FLIGHT, MAY 4, 1939

FIRST AERO WEEKLY IN THE WORLD

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FLIGHT

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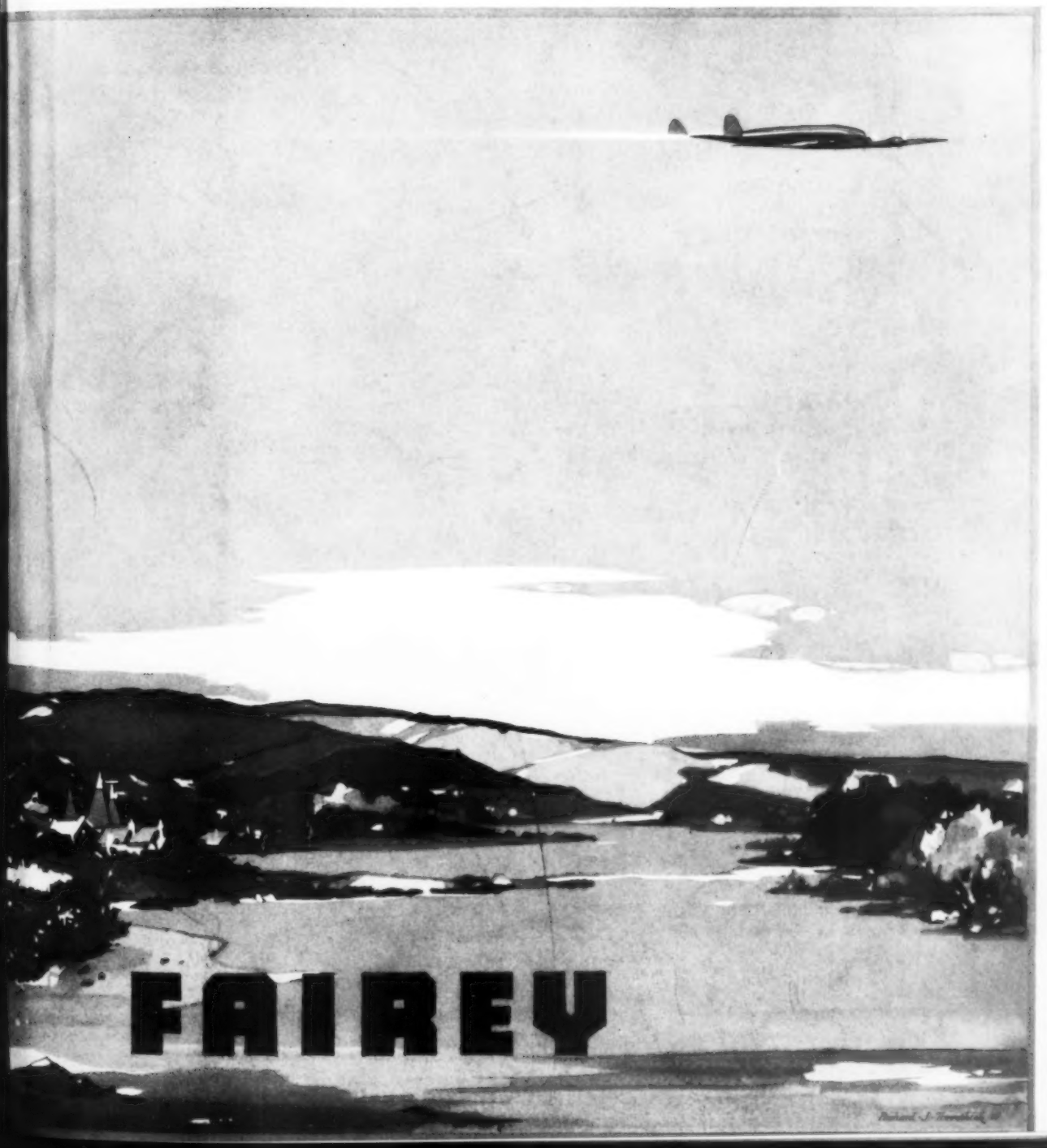
The AIRCRAFT ENGINEER

OFFICIAL ORGAN OF THE ROYAL AERO CLUB

No. 1584
Vol. XXXV



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"Bristol"

BLENHEIM BOMBER

FLIGHT
The AIRCRAFT ENGINEER

FIRST AERONAUTICAL WEEKLY IN THE WORLD : FOUNDED 1909

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The Outlook

More Atlantic Difficulties

OUR Editorial remarks in last week's issue have drawn from Sir Alan Cobham a long letter, which is published on our Correspondence page (p. 450). Sir Alan has slightly misunderstood our intentions with that Leader. He is, if we may so express it, thinking only of the tanker's end of the problem. We had in mind the fact that it takes two aircraft to make a refuelling, just as it takes two men to make a fight, and for the purpose of judging the problems of refuelling as a system it does not much matter at which end of the pipe line the difficulties arise.

Sir Alan Cobham, in his letter, stresses the fact that he is ready to refuel anyone anywhere. We do not doubt it. But he will scarcely deny that there have been snags. We hear different stories or, rather, different versions of the same story. One has it that when a flying boat is being refuelled one of the tanks will fill up before the others and petrol pours out through the vent; according to the other, the trouble has apparently been that when the tank is full the petrol overflows into the jettison system. We do not know which is the correct version, nor does it matter very much for the purpose of the argument that there are still teething troubles to be overcome before refuelling is a practical proposition. One cannot contemplate with equanimity petrol flowing about on or in the aircraft which is being refuelled.

Without a doubt these troubles will be overcome, but in the meantime there does appear to be a possibility that the Atlantic flights may not be able to start on the schedule date. That depends upon how soon things can be put right.

More than a year ago *Flight*, in a review of all the possible forms of assisted take-off, expressed the opinion that the future would probably show that there was room for all. That view we still hold. But we equally believe that detail problems still remain to be solved in refuelling, as in any of the other systems.

The Larger Questions

PROBLEMS like the even filling of tanks during refuelling, and the prevention of loose petrol flowing over a machine, are matters of detail. They will be solved in time, without a doubt. But what we have to do now is to look a little farther ahead and try to visualise how the future is likely to shape. *Flight* has for very many years held and expressed the view that on our long air routes mails and passengers should be segregated. That need is now more urgent than ever. It is common knowledge that on most of their trips the Empire boats carry only a few passengers, the rest of the disposable load being taken up by mails. That is unsatisfactory in two ways: It deprives potential passengers on the Empire routes of the advantages which air travel has to offer, and it means carrying mails in aircraft with hulls which are unnecessarily large and which, therefore, offer avoidable air drag.

To us it seems that the obvious solution is to take the mails away from the Empire boats, leaving these free for their legitimate function of carrying passengers, and to entrust the mails to much smaller, but very much faster, mail-carrying aeroplanes.

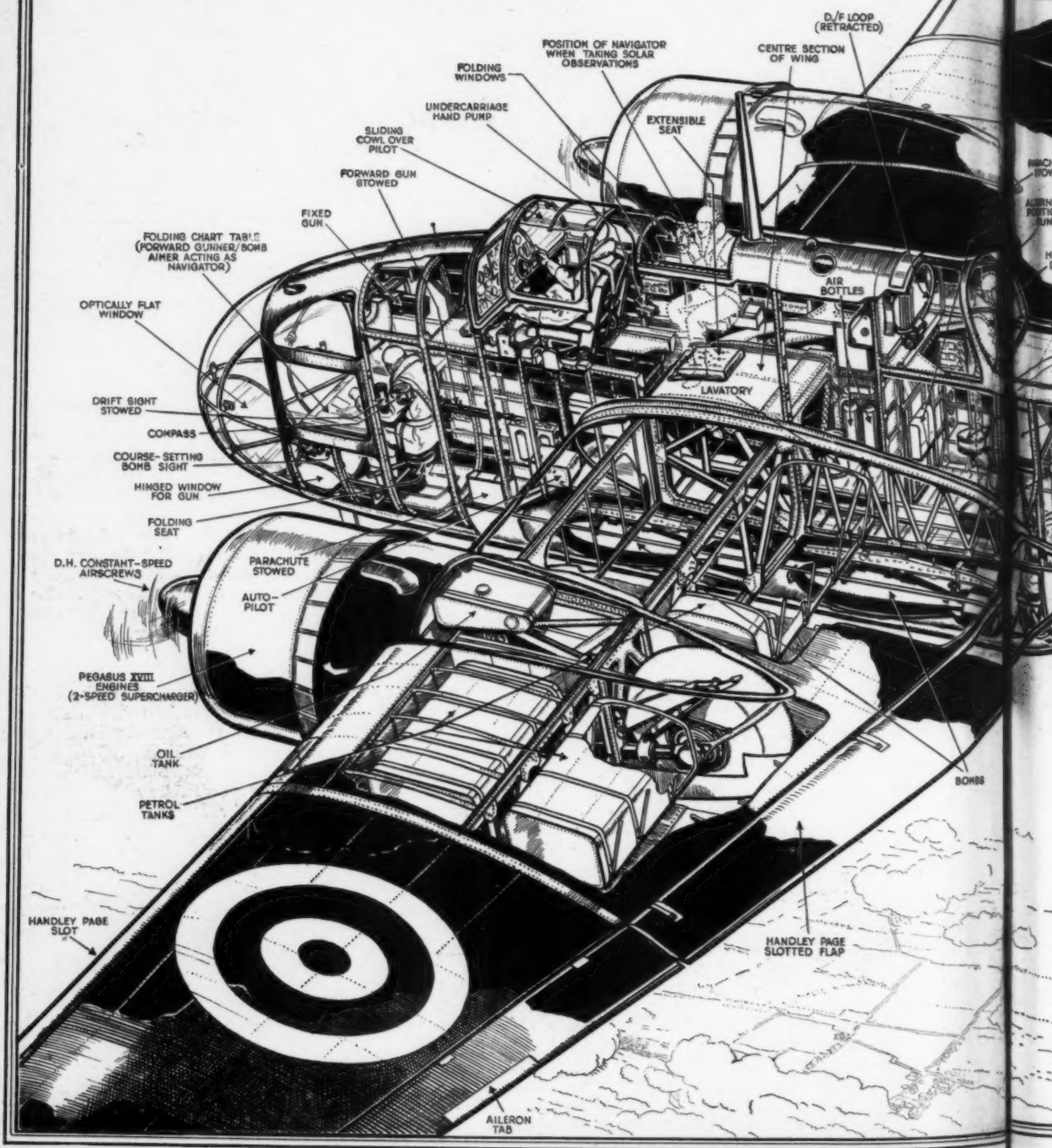
One of the great desiderata of any mail service is its frequency. For a given quantity to be transported that means smaller aircraft leaving at more frequent intervals. To get really high speed, very high wing loading will be necessary, although the fact that a machine was designed for carrying a very concentrated load, such as that provided by mails, would in itself enable the designer to provide extra efficiency and higher speed.

Surely the time has come when we should be thinking of air mails in terms of route speeds of the order of 250 m.p.h. If it is found necessary, in order to attain this, to use some form of assisted take-off, then let us by all means do so, and let us use that form which is

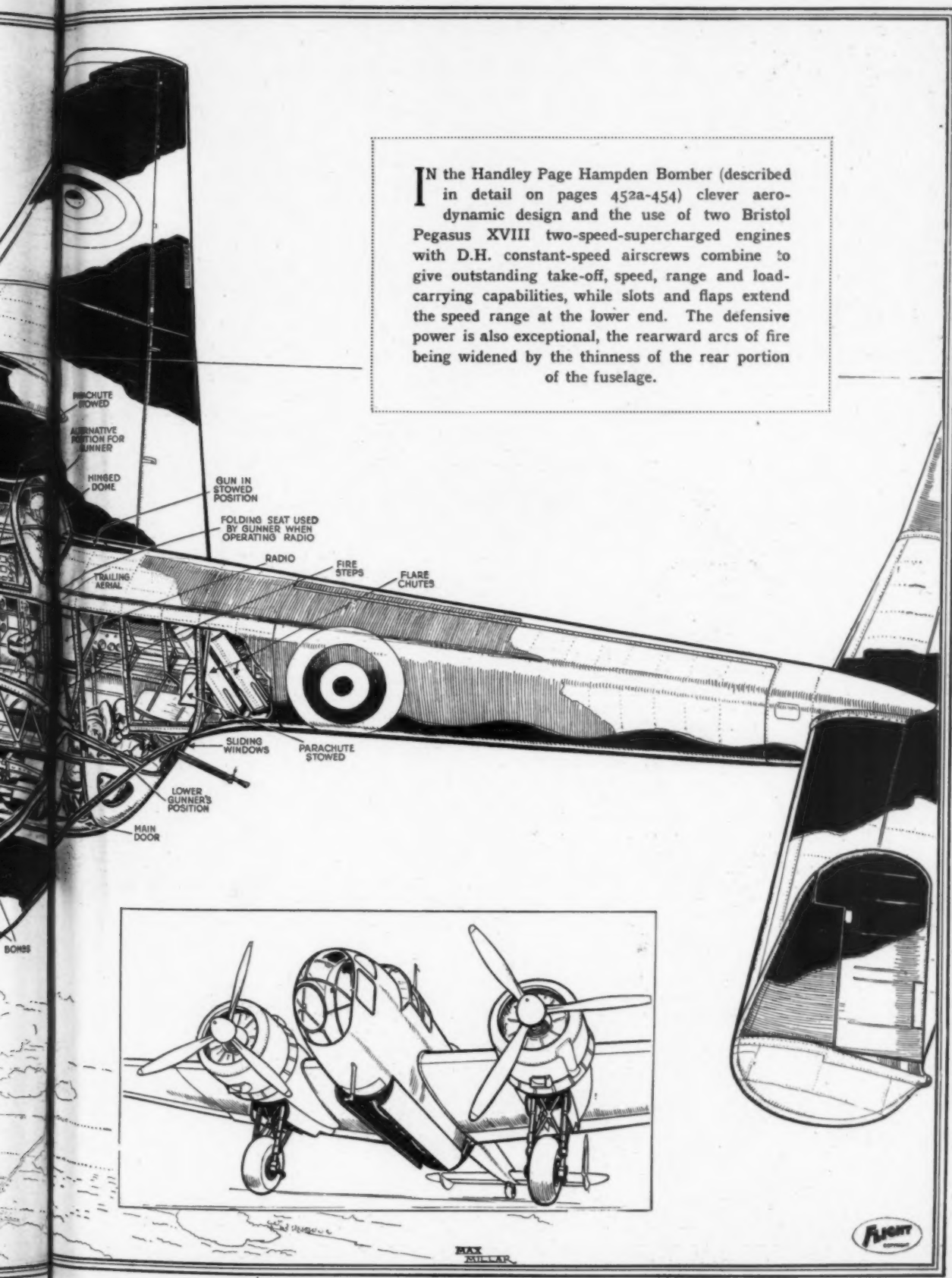
(Continued on p. 446, after the special drawing of the H. P. Hampden overleaf.)

FAST and FORMIDABLE

The Handley Page Hampden Bomber — a Special Drawing by Max Millar.



IN the Handley Page Hampden Bomber (described in detail on pages 452a-454) clever aerodynamic design and the use of two Bristol Pegasus XVIII two-speed-supercharged engines with D.H. constant-speed airscrews combine to give outstanding take-off, speed, range and load-carrying capabilities, while slots and flaps extend the speed range at the lower end. The defensive power is also exceptional, the rearward arcs of fire being widened by the thinness of the rear portion of the fuselage.



THE OUTLOOK (CONTINUED)

best suited to this particular requirement. The fact that when fully loaded the machine will probably be forced to fly very fast (owing to high wing loading) seems to point to the composite arrangement as the most promising solution. We have a perfectly open mind on the subject. But we do feel that the time has come when passengers and mails *must* be separated.

Scale Effect

THERE is a practical problem which does not appear to have been fully realised in connection with these very high wing loadings about which people talk so glibly. That is the effect of size. We know that the Schneider machines were loaded to about 41 lb./sq. ft., and that they handled fairly well, in spite of the "swing" on the water during the take-off. But is it safe to assume that a flying boat, for instance, with 50 lb./sq. ft., which is probably the sort of loading we shall have to adopt for high-speed long-range air routes, will be just as easy to handle? We do not, of course, overlook the use of tabs and servos and other such aids to reduce the physical effort required of the pilot. But all that apart, can the wing of a very large aircraft be "brought up" as quickly as that of a machine one-third the gross weight? We feel that it cannot; that such a machine must be somewhat sluggish in its fully loaded condition. That seems to have a considerable bearing on future policy.

There is not much information to go upon so far. The Dornier Do.X went into the air at a loaded weight of well over 100,000 lb., and it did not come to grief. But qualified observers have expressed the opinion that it had a gliding angle comparable with that of a brick. Admittedly the Do.X was very bad aerodynamically, with its double rows of engines above the wing, and modern four-engined flying boats have a very much better L/D ratio. But even allowing for that, it may be that huge aircraft with high wing loadings will be somewhat difficult to handle, at least in very bumpy weather.

Experimental Production

MUCH has been written and talked on the subject of how to get a large output of aircraft. Time was (and not long enough ago) when production was lagging badly behind. Fortunately, we have made rather marvellous strides during recent months, and the rate of output, were we able to publish it, would cause a pleasant surprise in some quarters and some consternation in others.

In the main, the increased output has been achieved by intensified production in existing "parent" factories, additions to these factories, and recently by the shadow factories. Except for the greater degree to which tooling and jigging has been made possible by the size of orders, aeroplanes are still being built in pretty much the same way. A recent exception is the Handley Page Hampden, of which an illustrated description is published this week. By an ingenious system of "split" construction, the usual bottle neck of production, the installation of equipment, has been avoided. The same principle could be applied to almost any type of aircraft, and the Handley Page firm has demonstrated that there is no great difficulty in training workers. What has been done at Cricklewood can be done elsewhere, and there does not appear to be any reason why, if Hampdens in large numbers are wanted, the shipbuilding firms should not build them in accordance with the system originated by the makers.

But in the meantime there is another form of production which is greatly in need of attention. The period which has hitherto elapsed between the appearance of the "hand-made" prototype and its issue to the R.A.F. in numbers is far too long. What is needed is some system whereby a relatively small number of "machine-made" versions of the prototype can be got out quickly and sent to the squadrons. These types would form the nucleus of our latest "hot-stuff" machines, and should be ready for action within a year or so of the first appearance of the prototype machine. Either our constructors will have to set aside sections of their works for the purpose, or factories will have to be built and very specially equipped. As soon as a type had gone into large-scale production these factories would go on to the next new type. Some such system would ensure that we always had a small but very efficient supply of the latest type of aircraft. The difficulties are obvious, but they will have to be overcome.

Another 5 m.p.h.

PUTTING five miles per hour on to the existing speed record does not sound a lot. It is sufficient to comply with F.A.I. regulations, but superficially it is not impressive. Yet anyone who has been in any way intimately associated or connected with speed record attempts knows that sometimes that last five m.p.h. is desperately difficult to get.

Knowing this, one applauds in all sincerity the recent attempt at raising of the world's speed record from 464 m.p.h. to 469 m.p.h. At the moment it is not too clear whether the flight by Capt. Fritz Wendel on the Messerschmitt monoplane ranks for record honours. The F.A.I. regulations stipulate that the course must be covered twice in each direction, and reports seem to indicate that Capt. Wendel only flew the course once each way (the speeds are given as 486, 456 and 469 average). Be that as it may, even if it should prove that Wendel did not actually beat the record, the significant fact is that Germany has two manufacturers who can produce aeroplanes capable of such speeds.

As we said at the time the previous record was established by Capt. Dieterle, one need not take too seriously the statement that the machine was a standard fighter available to the German Luftwaffe, nor that the rated power of the engine was actually all that was used. It is to be taken for granted that special doped fuels were used and that the engine was actually developing much more than the rated power of the normal service engine. That is of no consequence, except as a reassurance that the standard fighter would not, could not possibly, have quite such a spectacular performance.

Apart from the question of actual engine power delivered, the F.A.I. regulations do permit the machine to reach a height of 400 m. (1,312 ft.) during the turn at the end of the run, and a modern very clean aeroplane can derive quite a nice little burst of extra speed from that height.

The question that will be asked now is "what are *we* going to do about it?" The "N.N." racer being built by the Heston Aircraft Company may be capable of beating the figure of 469 m.p.h., although the speed of 500 m.p.h. which has been quoted for it is rather fantastic, at any rate in the view of the designer, who should know. It seems just possible that with the dive permitted it may be able to manage to beat the record.

LONDON-WARSAW

The Value of a New Air Link

By Col. H. St. C. SMALLWOOD, R.A.F. (Ret.)

THE recent closer understanding between Poland and Great Britain adds lustre to the first flight on the London-Warsaw service inaugurated by British Airways on Monday, April 17.

There were nine passengers on the Lockheed 14, which left Heston at 12.30. These included the Polish Military and Air Attaché, Lt. Col. Kwiecinski; the Polish Commercial Counsellor accredited to the Court of St. James'; Lt. Col. Sir Francis Shelmerdine, Director of Civil Aviation; and Major McCrindle, the managing director of British Airways. I myself was proceeding to Poland to give a series of lectures to Anglo-Polish societies in such centres as Warsaw, Kielce, Katowice, Lwow and Gdynia.

Activity amongst the cinematographers and Press photographers before we left Heston caused a short delay, but it was not revealed in the time of our arrival in Warsaw, which took place at almost exactly the advertised hour. During the flight itself there was as little incident as is to be expected on a well-managed service. We seemed to be not more than half an hour crossing the sea, but ground visibility was very poor, and a large part of the flight was made in sunshine above the clouds. Although there was little to be observed but cloud scenery, there is certainly an undoubted thrill about first flights as there is about first nights, and all the passengers felt they were taking part in an event of some importance.

As we climbed it became colder, though the temperature inside the machine was well regulated. At between ten and eleven thousand feet ice was forming on the windows; this, however, disappeared quickly as we began to descend.

"Flight" photograph.

WHEN Col. Smallwood (seen above) went to Poland to lecture to Anglo-Polish societies, he travelled by the inaugural British Airways service from London to Warsaw. In this special article for "Flight" he gives his impressions of the journey and of the reactions of the Polish people to the new service.

At about three p.m. we were heading for Tempelhof airport at Berlin. At six thousand feet we began to get glimpses of the densely wooded and generously watered countryside near the capital. Many lakes of vast area broke up the forest scenery and, as we passed those nearest to Berlin, little miniature launches and boats were visible on these healthy playgrounds of Young Germany. Before landing we ran into a perfect blizzard of sleet, and on the ground the rain was falling heavily. Considering the variations of weather, and the various cloud strata we had passed through, the flight had been very steady, and no use was made of those emergency bags which are conveniently placed in pockets at the side of each seat.

A few words about the interior equipment of the Lockheed will, perhaps, not be out of place. The seats of blue leather are very comfortable, and can be tilted to suit each passenger's comfort merely by the pressing of a button. There are ample racks for small articles of luggage; a comforting little envelope given to each passenger contains a *Reader's Digest* and cotton-wool for the ears, thus showing considerable forethought for the comfort of the traveller. At about one o'clock an attractively presented luncheon was served by the steward, consisting of a cup of soup, a plate of assorted cold meat, a sweet and cheese—and at 10,000ft. the biscuits made an oddly "crunchy" sound in the head.

Visibility in the rear seats is somewhat obscured by the wings, but this is obviously unavoidable.

As we landed at Berlin the Fowler flaps could be observed creeping out from under the wings, enabling a much slower landing to be made than could be done without them, though I was told that the increased wing surface, naturally giving increased lift, demanded a special technique of the

The Lockheed Fourteen at Heston on April 17. The Fowler flaps are in the half-way position, while the "letter-box" slots may just be seen near the wing tip.

pilot. A perfect landing was made, and at a surprisingly slow pace when one considers the cruising speed of the Lockheed 14. There are also special slots in the wing which give increased stability near the ground.

One of the things which struck me particularly was the way in which the *autobahnen* stood out from the air. These motor roads would be difficult to camouflage in any war, and should be of considerable use to a pilot finding his way across German country.

On landing at Berlin we were greeted by the officials of British Airways and of the Compagnie Aérienne Polonaise, who led us into the aerodrome restaurant and regaled us with cakes, coffee and drinks of various kinds. After half an hour's chat with them and with some journalists we boarded the aeroplane again and were soon soaring off on our way to Warsaw, the destination of this pioneer commercial flight.

The friendly attitude of the Polish officials in Berlin and their enthusiasm for the occasion had been very marked. The landing at Warsaw was another occasion for much enthusiasm. Many officials from the Ministry of Communications, and from the British Embassy, British Airways, and the Polish air organisation, were on the tarmac to greet the machine, and words of hearty welcome were spoken. The aerodrome itself is most impressive—very flat and free of obstructions, and possessing all the ground organisation necessary for an up-to-date airport. Warsaw is well provided with first-class facilities for aerial communication, nearer to its centre than many European capitals; a quarter of an hour's drive took us to the centre of the city.

The Service's Importance

The significance of this first flight must not be overlooked. At a time when Poland and Great Britain have come to a close understanding on the subject of defence, it is of the utmost importance that there should be an aerial link. To have brought Warsaw and London within six hours of one another is no small feat. All letters from London to Warsaw will in future travel by air, and the first aerial mails for London are now leaving Warsaw by the same means. It would be difficult to overestimate the advantages of this speeding-up of communications. Polish thoughts can be known and understood in London a few hours after they have passed through the minds of the Poles, and the reverse of the picture is also an obvious truth. The satisfaction felt by the Poles, not only in Warsaw, is very evident, and the feeling that Great Britain and Poland are very far apart is rapidly being dispelled.

The spirit of determination in every Polish citizen—man, woman and child—is quite amazing. Young students do a preliminary period of voluntary drill before their actual military service begins, and elderly ladies shoot on ranges with rifles, partly that they be able to shoot accurately when the time comes and partly as an example to the younger women. The enthusiasm for the British people and for everything British is most evident, and this should be stimulated by more English language journals reaching Poland quickly—and therefore by air. Those who can teach English have their time more than fully occupied, and Anglo-Polish societies flourish, even in the lesser towns and cities. English news is eagerly listened to on the radio, the news spoken in German being particularly popular. Apart from the German-speaking minority, a very large number of Poles speak and understand German, and that language, therefore, is probably the most suitable in which to disseminate British news and culture in Poland.

Poland as a Tourist Centre

Polish airways are run by the Ministry of Communications, and appear to be efficient and increasingly popular amongst the business men. The question of shortage of foreign exchange is a very prominent one, so the encouragement of the tourist industry is very much in the minds of the Ministry. Efforts are being made to popularise Zackopany as a ski-ing resort. Situated in the picturesque Tatra mountains, it can be reached comparatively easily if advantage be taken of the London-Warsaw air service. If the aeroplane is taken at midday in London, Warsaw is reached at 6.30 in the evening, and one night spent on the train brings one to Zackopany—in other words, a reasonably comfortable journey of about eighteen hours. Just now many bronzed faces are to be seen, ocular evidence of the sunny snow slopes of the Tatras.

Apart from the interest in civil aviation, there is a tremendous wave of enthusiasm passing over the country for the Air Service defence against aircraft attack. There is a big air defence loan now being canvassed. The authorities hoped to get fifty million *zlotys*, but already more than two hundred million (approximately eight million pounds) have been subscribed. Subscriptions have come from the rich and powerful and from the almost penniless peasants. Subscriptions of one *zloty* have been offered by people who have denied themselves food to produce this one coin of less than a shilling.

Enough has been said to show the fine spirit of patriotism which animates the Poles, and there is no doubt they have been heartened and encouraged by the initiation of the London to Warsaw air service, so efficiently conducted by British Airways.

FITTING CEREMONY FOR A FINE AEROPLANE

THE hope that last Friday's party staged to "launch" the Handley Page Hampden bomber would not detract too much from the publicity expected at the same hour by a certain eminent gentleman abroad was expressed by Mr. F. Handley Page, speaking at the works aerodrome at Radlett on that occasion.

The ceremony was performed by Capt. Balfour (Under-Secretary of State for Air)—in the unavoidable absence of Sir Kingsley Wood—and by the Parliamentary Air Committee, foreign air attachés, high officials of the Air Ministry and many other notable people.

Capt Balfour made the actual announcement that full details of the Hampden could be made public as from that time, and himself explained some of the outstanding features of its performance. He also told his audience that Hampdens were now being built by the English Electric Co. (The announcement of that intention was made last December.)

Earlier, at the Cricklewood works, the party had been able to see the Hampden "split" method of construction (described in detail on pages 452a-454 of this issue. Mr. Handley Page personally conducted Capt. Balfour and one party round the works, while Group Capt. Maycock, Mr. Russell and their colleagues of the H. P. staff were exceptionally busy helping other visitors. At Radlett the guests saw the final assembly—under the direction of Mr. McRostie.

The fine display of flying at the aerodrome surpassed most expectations. Major Cordes, Handley Page's chief test pilot, assisted by Flt. Lt Talbot, showed that the Hampden could be handled almost like a fighter and, while having an extremely creditable top speed, can comfortably "under-fly" any comparable type at the other end of the speed range. With the aid of its copious slotting and flapping, the Hampden appeared almost to hover during the demonstration of slow flying.

The two machines demonstrated were straight off the assembly lines and, on landing, they were taken over by R.A.F. officers, who signed the necessary papers and took delivery for their squadrons.

On three Hampdens already in service, members of a Bomber Squadron showed that, although comparatively new to their machines, they had fully mastered formation flying in them—and, incidentally, they helped to bear out Capt. Balfour's flattering words concerning the superiority of our Air Force personnel. It was a happy thought to invite the C.O.s of Hampden squadrons on this occasion, and pleasant to have so many enthusiastic Service pilots present.

In the course of the speeches immediately preceding lunch, Mr. Handley Page explained the unusual production system adopted for the Hampden, and said that the primary aim was not to get as many machines going through the works as possible, but to get the maximum number of men working simultaneously on one machine. As a result the parts of one machine took little more than a week to progress from raw material to final assembly at Radlett.

Rear Admiral Sir Murray Sueter, M.P., thanked Handley Page's, on behalf of the Parliamentary Air Committee, praising Mr. Hamilton (director and works manager) and the whole staff for their skill and enthusiasm.

THE ROYAL AERO CLUB

News and Official Notices for *the Week Ended April 29*

Aero Club Elections

ONE of the most active supporters of aviation in England, Sir Lindsay Everard, M.P., has again been elected Chairman of the Royal Aero Club. Sir Lindsay, in addition to being a member of the Parliamentary Air Committee of the House of Commons, is the owner of several private aircraft and a fully equipped aerodrome at Ratcliffe, and is a Commissioner of the Civil Air Guard. He has been Chairman of the Royal Aero Club for the past three years and was this year unanimously re-elected.

Other elections concerned the Racing Committee, the House Committee, the Finance Committee and the Private Owners' and Air Touring Committee. At the same meeting the Secretary of State for Air, Sir Kingsley Wood, and the Chief of the Air Staff, Air Chief Marshal Sir Cyril L. H. Newall, were made honorary members of the Club.

Certificate Number Quintupled

ANOTHER new record in the number of Aviators' Certificates issued by the Royal Aero Club has been set up. In the five weeks ended April 25, 445 Certificates were issued, which is the highest number yet reached for such a period. Figures recorded at previous Committee Meetings were 256 at the end of March, 190 at the end of February, 169 at the end of January, and 196 at the end of December. The total for the four months of the present year has now reached 1,060, which compares with the 217 for the corresponding period of 1938, and represents approximately a five-fold increase.

Meanwhile, Gliding Certificates are also on the increase, and the present activities with the Air Defence Cadets are likely to give the figures a further fillip.

Wakefield Challenge Trophy Race

THE rules governing the Wakefield Challenge Trophy Race, which is to be flown at Birmingham Airport on September 2, are now available on request from the Secretary, the Royal Aero Club. Aircraft holding an Air Ministry "Permit to Fly" are allowed to compete. This will make all types of machines designed and built for C.A.G. purposes eligible. The Race is to be run concurrently with the King's Cup Air Race, and the system of handicapping is similar.

Piccadilly Pilota Picnic

SEVERAL distinguished Hungarian pilots have accepted an invitation by the Automobile Association and the Royal Aero Club to visit England by air on May 13, leaving on May 17. The programme will include an evening at the London Casino to enable those British pilots who have had the good fortune to partake of Hungarian hospitality at the Magyar Pilota Picnics to welcome our friends from Hungary. All those pilots who wish to assist in the entertaining of the guests should send in their names to the Automobile Association or the Royal Aero Club.

Club Stewards, 1939

THE Royal Aero Club Stewards for 1939 are: The Duke of Atholl, K.T., G.C.V.O.; the Marquess of Londonderry, K.G., M.V.O.; Lt.-Col. Sir Francis K. McClean, A.F.C.; Lt.-Col. M. O'Gorman, C.B.; Col. Sir Joseph Reed; The Duke of Sutherland, K.T. Stewards of the Club are the final Court of Appeal on any dispute or disqualification in connection with Air Races.

Aviators' Certificates

No.	Name	Club or School	Date
17,760	George Wilmot Nokes	Romford Flying Club	12.4.39
17,761	Arthur Leonard Kermode	Hampshire Aeroplane Club	18.4.39
17,762	Reginald James Pounds	Insurance Flying Club	11.4.39
17,763	John Noel Hinds	Coventry Aeroplane Club	20.4.39
17,764	Frank Taylor	County Flying Club	19.4.39
17,765	Douglas William Brokenbrow	Bristol and Wessex Ae. C.	19.4.39
17,766	Edward Ernest John Adams	Wiltshire Flying Club	2.4.39
17,767	Cyril Albert Adams	Wiltshire Flying Club	11.4.39
17,768	John Toker Clough Hazeldine	Thanet Aero Club	11.4.39
17,769	Charles Harold Wood	Yorkshire Aeroplane Club	19.4.39
17,770	John Cedric Addy	Southend Flying Club	20.4.39
17,771	John Lawson Glover Carruthers	Southend Flying Club	20.4.39
17,772	Eric Wright	Southend Flying Club	20.4.39
17,773	John Charles Atkinson	York and Leeming F.C.	20.4.39
17,774	Jack Haverfield Dales	York and Leeming F.C.	18.4.39
17,775	Roger Clifford Erskine Goodeve	Leamington, Warwick and Dist. Ae. C.	14.4.39
17,776	Christopher Horace Jermyn Brown	Ipswich Aero Club	19.4.39
17,777	Horace Edgar Thorogood	Ipswich Aero Club	21.4.39
17,778	Peter Allan Rippon	Lancashire Aero Club	19.4.39
17,779	Gordon Morrison-Walker	Hull Aero Club	18.4.39
17,780	Herbert Bradley Warburton	Hull Aero Club	10.4.39
17,781	George Leslie Bland	Norfolk and Norwich Ae.C.	20.4.39
17,782	Althea Constance Goldberg	Tollerton Aero Club	14.4.39
17,783	George Alfred Pearson	Tollerton Aero Club	14.4.39
17,784	Mary Duncan	Lincolnshire Aero Club	20.4.39
17,785	Herbert George Cant	Portsmouth Aero Club	20.4.39
17,786	William Ivor Palmer	Worcestershire F.C.	21.4.39
17,787	Kenneth Charles Bright	Worcestershire F.C.	19.4.39
17,788	Allen Harding	Wiltshire School of Flying	11.4.39
17,789	Donald James Sutherland	Cinque Ports Flying Club	20.4.39
17,790	Frank Maitland Jarrett	Airwork Flying Club	20.4.39
17,791	Alan Robert Harvey	Airwork Flying Club	9.4.39
17,792	Stanley Bernard Johnson	Airwork Flying Club	20.4.39
17,793	Charles Edward Neil O'Rourke	South Coast Flying Club	10.4.39
17,794	Harold Charles Lawrence	London Aeroplane Club	20.4.39
17,795	Axe Gunnar Anderson	London Aeroplane Club	19.4.39
17,796	William Francis Selby	Plymouth and Dist. Ae. C.	21.4.39
17,797	Philip Henry Stanton	Plymouth and Dist. Ae. C.	21.4.39
17,798	Richard John Miller	No. 20 E and R.F.T.S., Gravesend	23.3.39
17,799	Bernard Tresham Hardy	West Suffolk Aero Club	21.4.39
17,800	William Fowlie	Herts and Essex Aero Club	19.4.39
17,801	Samuel George Ridley Hunter	Herts and Essex Aero Club	19.4.39
17,802	James William Henry Brown	County Flying Club	20.4.39
17,803	Muriel Constance Burke	Thanet Aero Club	21.4.39
17,804	Geoffrey Ginn	Lincolnshire Aero Club	21.4.39
17,805	Frank Vere	Lincolnshire Aero Club	20.4.39
17,806	Thomas Turnbull Davidson	Newcastle-on-Tyne Ae. C.	6.4.39
17,807	Leslie Horace Lee	Leicestershire Aero Club	22.4.39
17,808	Kenneth Edgar Herridge	Yorkshire Aeroplane Club	21.4.39
17,809	Louis Warren Darley	London Aeroplane Club	21.4.39
17,810	Donald Howard Jeffs	London Aeroplane Club	20.4.39
17,811	John Melvill Jennings	London Aeroplane Club	22.4.39
17,812	Irene Sylvia Haslewood	London Aeroplane Club	23.4.39
17,813	George James King	Romford Flying Club	20.4.39
17,814	Kathleen Mary Lett	London Air Park F.C.	24.4.39
17,815	John Stuart Lawson Crabb	London Air Park F.C.	7.4.39
17,816	Patrick Louis Villette Hutt	Misr Airwork Flying Sch., Almaza, Egypt	21.4.39
17,817	Patricia Cawood Woollan	Eastbourne Flying Club	16.4.39
17,818	Jack Hope Simpson	Yorkshire Aeroplane Club	21.4.39
17,819	George Edward Priddle	Midland Bank Flying Club	22.4.39
17,820	Russell Robert George Reid	Midland Bank Flying Club	23.4.39
17,821	Eric Brooke Moorhouse	Doncaster Aero Club	23.4.39
17,822	Edward Morrison	Northern Aviation Club	20.4.39
17,823	Edward Ralph Forster	Northern Aviation Club	20.4.39
17,824	John Roland Whiting	Redhill Flying Club	23.4.39
17,825	Frederic William Mason	Romford Flying Club	20.4.39
17,826	John Clapham	Hull Aero Club	21.4.39
17,827	Francis Alan Ross	Hull Aero Club	23.4.39
17,828	George William Coultous	Hull Aero Club	23.4.39
17,829	Stanley Evelyn Scott	Hull Aero Club	23.4.39
17,830	Serge Charles Bentley	London Aeroplane Club	22.4.39
17,831	Donald Boyd Heron	Kent Flying Club	23.4.39
17,832	John Dixon Habin	Hampshire Aeroplane Club	20.4.39
17,833	Ronald Edward Pearson	Horton Kirby Flying Club	24.4.39
17,834	John Robert Hiscock	Cambridge Aero Club	8.4.39
17,835	Norah Frances Vernon	Cambridge Aero Club	8.4.39
17,836	Dennis Harry Newton	South Coast Flying Club	19.4.39
17,837	Patricia Joan Allen	Romford Flying Club	22.4.39
17,838	Edgar Thomas Clarke	Tollerton Aero Club	20.4.39
17,839	Helen Mary Wilcockson	Tollerton Aero Club	20.4.39
17,840	Alfred Searle Kenneth Paine	Tollerton Aero Club	19.4.39
17,841	Wilfred Butler	Tollerton Aero Club	20.4.39
17,842	Jeffery Sprague	Doncaster Aero Club	25.4.39
17,843	Neil Mussen Campbell	Cinque Ports Flying Club	25.4.39
17,844	Ronald Thomas Amos	Kent Flying Club	25.4.39
17,845	William Edward James Taylor	Kent Flying Club	23.4.39
17,846	Katharine Mary Simpson	Hampshire Aeroplane Club	20.4.39
17,847	Denys Martin Callow	Leamington, Warwick and Dist. Aero Club	24.4.39
17,848	Leonard Hayes Phillips	Southend Flying Club	23.4.39
17,849	Leonard Francis Cradock	Cardiff Aeroplane Club	21.4.39
17,850	Walter Medland	Cardiff Aeroplane Club	19.4.39
17,851	Edward John Gracie	501 (County of Gloucester) Squadron, A.A.F.	20.4.39
17,852	Rupert Rolfe Larke Mitchell	Horton Kirby Flying Club	20.4.39
17,853	Joseph Ayers Keep	Leamington, Warwick and Dist. Aero Club	24.4.39
17,854	Peter Montagu Sims	Yorkshire Aeroplane Club	18.4.39
17,855	John Tweedale	Lancashire Aero Club	20.4.39
17,856	William Lingford	Thanet Aero Club	26.4.39
17,857	Albert Edward King	Witney and Oxford Ae. C.	25.4.39
17,858	John William Wheatley	Herts and Essex Aero Club	27.4.39
17,859	Ernest George Phillips	South Staffs Aero Club	12.4.39

CORRESPONDENCE

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

C.A.G. RECRUITS AND NATIONAL SERVICE

An Organiser's Experience

I HAVE read with interest the remarks of "Indicator" in "Topics of the Day" in your issue of April 13 and as a C.A.G. secretary am unable to understand his allusion to the alleged uncertain position in the matter of new C.A.G. applicants. In fairness to the Commissioners, I have found that the position, although unsatisfactory in some respects, would appear to be perfectly clear.

When it was announced some time ago that all the immediate vacancies in all classes of the Civil Air Guard had been filled, I took it upon myself to write to the Secretary to the Commissioners pointing out that at Rearsby, although we had a sufficient number of applicants for week-end training, we were still short of reserves for week-days, and immediately received a very courteous reply giving permission for us to keep our lists open in our discretion, and to advertise if necessary. Accordingly, our lists have never been closed and are still open. We have, however, undertaken not to accept a greater number of applicants than we can train within a reasonable period. Our Air Ministry enrolments have been coming through regularly as the medicals have gone in and I am accordingly puzzled at the experience of the club your contributor mentions. I cannot believe that the Commissioners are at fault.

As I see it, this National Service clearance requirement is the greatest difficulty so far encountered. Out of 50 recruits which I have submitted to the local Ministry of Labour for clearance during the past three weeks, 17 have been rejected. Of these, the majority have been in Class II during the winter months and have been taking ground instruction and attending lectures. As a result they have acquired an admirable keenness in connection with their prospective Air Guard membership and are now bitterly disappointed. Further, we are told that before existing "A" licence holders can volunteer for the "starred" classes, they must be cleared by the local National Service authorities. This is bound to react unfavourably on the numbers in these classes in the clubs in the large industrial areas. By far the greatest number of our applicants rejected are engineers, electricians and factory operatives. Perhaps it is reasonable for the Government to include such men in the reserved occupation categories, but I have a feeling that in the event of hostilities the majority of them would find their way into the infantry.

Capt. Balfour, Under-Secretary of State for Air, during his visit to the Handley Page works (reported on p. 448) tries his hand at riveting, watched by Mr. Handley Page and Mr. S. R. Worley (chairman).

I am informed that the National Service list of reserved occupations has been considerably modified in connection with applications for enlistment in the Territorial Army and the R.A.F.V.R. Obviously this is a step which ought to be taken, and quickly, in connection with the Air Guard.

C. H. GOUDE,
Hon. Secretary (C.A.G.), County Flying Club, Ltd.

SERVICE AT LYMPNE

Another Defender

From Sir George Lewis, Bt.

I HAVE read the letter written to you by Mr. Foster, of the Eastbourne Flying Club, in the issue of *Flight* of April 6.

Whilst I am in agreement with your correspondent on the question of landing fees for private aircraft, I am much surprised at his complaint of lack of attention at Lympne Airport. My own experience is exactly the contrary.

Whenever I use Lympne I invariably find that the officials and staff are courteous and helpful and do everything in their power to be of assistance. It is for this reason that I and others besides often make use of Lympne when flying to and from the Continent, although there is usually no necessity to do so.

London, W.1. GEORGE LEWIS.

FLIGHT REFUELLING

Sir Alan Cobham Comments on the Atlantic Arrangements

IN last week's issue of Flight, reading the Editorial comments, I was most concerned with your remarks under the heading "Atlantic Difficulties."

If I might be permitted to suggest—although I take no exception to the actual words used—the innuendoes are such that they would give to the uninitiated on the subject an entirely erroneous impression.

In your first paragraph you remark that "the operational staff of Imperial Airways and the Directorate of Civil Aviation have held somewhat different views about the matter of Atlantic flying methods." You further insinuate that the Air Ministry is in favour of flight refuelling while Imperal Airways is not. Naturally, this is entirely wrong, because both the Air Ministry and Imperial Airways believe in flight refuelling.

I do not know whether or not the Air Ministry is "tending to decide in favour of the refuelling scheme." If that is so, it is pleasant news to me!

No doubt the hard work that Flight Refuelling, Ltd., has put in with its staff of nearly a hundred men, during the last three years, has borne fruit; and no doubt that very famous report on "High Wing Loading" that was prepared by the technical staff of Flight Refuelling, Ltd., and issued in confidence to the technical staff of the Air Ministry and also to Imperial Airways, has convinced them on the aerodynamical side of this question, and cleared up and finally proved a matter which has been treated in the past in rather a haphazard manner.

In your notes you further state that, "as far as refuelling is concerned, this is by no means the simple or reliable affair that it is sometimes considered to be." You state that "a number of operational difficulties have still to be overcome." I flatly deny the inferences in these statements.

A protracted argument on this subject is hardly possible in a letter. All I can say is that when the time comes we shall be ready to refuel the Atlantic service or any other service, and that all we want is the aircraft to refuel.

If refuelling is to be a success, it has got to be perfect the first time—and I should like to tell you, sir, that it will be.

You mention that "not until a series of scheduled flights across the Atlantic are attempted can it possibly be discovered whether the scheme may be used for any but special long-range flights."

This may be right, but I don't know what you mean by "special long-range flights." A flight refuelling range should be about 3,000 miles. We don't want to bother with flights of less than 2,000 miles. Our idea is London-New York, non-stop. Refuelling can do it.

Another point you mention is that, "even with the most ingenious adaptations, any machine-to-machine transfer of fuel must be a difficult process, demanding considerable skill on the part of the crews concerned, and it may be that the operation

(*Concluded on page* 460.)

WINTER OPERATIONS : An early morning scene at the Dominion Skyways' Semmeterre base in Canada. A Bellanca is being refuelled in the foreground while a Fairchild is still resting in its nose-hangar.

TOPICS of the DAY

The Forgotten Men Again

FOR a long and weary period of time—in fact, since the start of the C.A.G. scheme—I have been asking that something special should be done about the class of pilot which can only be covered by the words "experienced amateurs." There must be hundreds of "A" licensed pilots, with anything from 200 to 1,000 hours flying to their credit, for whom C.A.G. membership appears to be something of a waste of time, and yet who, at the same time, do not feel that it would be very sensible to sign on for an emergency job of work which would make no use whatever of their flying experience. Some of them have lost heart and attached themselves to balloon units and so forth, but the majority are just carrying on in the hope that the Air Ministry may eventually discover that beneath their very noses they have an ample reserve of pilots who, with very little additional training, could usefully become either *ab initio* instructors or ferry pilots.

Those reasonably competent amateurs who are within the necessary age limits can, of course, join the Volunteer Reserve, or, if they have the money and there are any vacancies, one of the Auxiliary squadrons. But the greater majority of them are between the age of 30 and 40, largely because, in the ordinary way, only those amateurs who have been flying with clubs for more than nine or ten years are likely to have put in a sufficient number of hours to bring them into the suggested category.

Something *can* be done about these people, and it has always been my opinion that the Air Ministry, via the C.A.G. Commissioners, is wasting its time in training newcomers before giving the pilots already in existence a chance to do something really useful.

In the circumstances it is at least comforting to find, at last, that one of our more important newspapers has taken up the matter. Last week *The Times* gave a concise explanation of the position where "veteran pilots" were concerned, though I thought that the suggestions made were still inadequate. The older pilots might be offered a chance of carrying out instructors' courses—with, possibly, an implied promise that they will help their own club when necessary—but what they really require is co-pilot experience with modern military machines.

Only the lucky few who have had a chance of flying up in front in machines like D.C.2 and Fourteen—and still fewer who have been up in a dual Blenheim or Harrow—are likely to know very much about the flying of present-day large-sized machines. In these the work is actually far more in the nature of applied engineering than piloting as such. It is as easy to land a big machine as a small one—but not if you have forgotten to pump the undercarriage down. The main difficulty in flying advanced aeroplanes is in memorising quite automatically the routine for take-off and approach; in other words, in remembering to remember the dozen things that have to be checked or done.

Agreed there are considerable difficulties in providing such experience, and the only way to do it would be to send certain picked pilots to fly either with squadrons on certain days, or, if this requires the cutting of over-much red tape, to fly as co-pilots on test and delivery trips.

A Possible Niche

WHILE thinking of this need for gaining experience, it might be said here and now that there is at the present moment the most phenomenal shortage of reasonably experienced "B" licensed pilots. Some charter pilots are putting in far more hours of day and night flying than they should be. I know of cases where pilots have been out on a photographic job for a newspaper from, say, five in the morning, and almost immediately on their return they have had to go up on co-operation work between 10 p.m. and 1 a.m. or thereabouts.

Provided that these pilots are quite happy to fly ten or twelve hours a day, all well and good. They are certainly making money. But here, perhaps, is a chance for these experienced amateurs to do something useful, and, at the same time, gain very important additional experience. No more than one per cent., if that, of those who may be termed the veterans have done any serious night-flying. Most of them have done a little dual, or been up as a passenger, but at present the cost of night-flying instruction is much too high for those who are not actually going out for a "B" licence.

If there really is this shortage of pilots and the degree of overwork about which one hears, then this is a magnificent way out of the difficulty. After ten hours of practice take-offs and landings in a twin-engined machine at night, any 300-hour pilot should be quite capable of flying drearily round the sky for a couple of hours, leaving the pukka (Dear me! Where did that ancient adjective

Topics of the Day

come from?) commercial pilots to do the various jobs which require real experience and real skill.

Of course, the immediate and obvious difficulty would be that concerning machine insurance. The rates might be fairly high for a start, but this cost would be very much more than balanced by the fact that little or no payment would be offered to the blackleg amateurs. All would be done, needless to say, with the support of the G.A.P.A.N. and the B.A.L.P.A. Perhaps such support could, by fair means or foul, be levered out of these earnest organisations.

Where Are They?

TO change the subject entirely, I met someone the other day who has spent the greater part of the last year in Germany, and claims to have seen, in all that time, only about three military formations, and these of out-of-date types. Obviously, a tremendous lot of flying *must* be done over there, but, unless all of it is carried out over unpopulated areas in East Prussia and elsewhere, it is hard to resist the silly conclusion that this German Air Force might business is partly bluff.

For my own part I have spent perhaps a total of two months in Germany during the last three years, and I have certainly never seen anything more exciting than a single Junkers Ju.86 or Ju.52 with an incongruous-looking gun sticking out of it. I have seen two Messerschmitt 109s and one Heinkel at a flying display, but none in formation and none looking as though they were really going anywhere or doing anything.

In this backward country we see formations of up-to-the-minute machines all day and every day. Some of the Auxiliary pilots are murmuring round in flocks of Blenheims, and even the Reserve people have done rather more than just look at Battles. Now that we're going ahead I hope we don't get obnoxious and wave the big stick. It is the strong who can best afford to be generous.

INDICATOR.

FROM the CLUBS and SCHOOLS

LONDON.
THE flying time for last week amounted to 109 hr. Mrs. L. W. Ball and Mr. C. W. W. Cooper went solo Mr. K. Johnson and Col. Medlicott have joined as club members.

IPSWICH.
High winds reduced flying time during the week ended April 25 to 60 hr.

NEWCASTLE.
Club flying time for the last fortnight amounted to 98 hr. C.A.G. members recorded 103 hr. Mr. N. Atkinson has gone solo.

HERTS AND ESSEX.
Last week club flying was somewhat hampered by the April showers. Over 195 hr. were recorded in the past fortnight. Messrs. Miller Faint, Hyatt, Worton and Burns have gone solo.

HANWORTH.
Last week the club's aircraft flew 130 hr., of which 98 hr. were recorded by the C.A.G. section. Messrs. A J. Macdonald, C. M. McClure and L D. Wilder have gone solo

STRATHTAY.
A total of 36 hr. was recorded last week in spite of unsatisfactory weather. Messrs. Thorburn, Grant and Russell have gone solo. Mr. C. J D. Rennie has joined as a flying member.

WITNEY.
Flying time for last week amounted to 72 hr., which brings the total for the month up to 224 hr. Messrs. C. Bateman and R. M. Abraham have gone solo

LINCOLNSHIRE.
Although on several days during the past month the weather conditions were unfavourable, 190 hr. were recorded. Seven members of the C.A.G. section have been placed on the starred list.

BEDFORD.
Poor weather conditions somewhat curtailed the flying time for last week. Messrs. O. Cramer, F. Dutson and C. W. Stubberfield went solo. Three new members have joined the club.

JOHANNESBURG.
During the month of March, 768 hr. flying time was recorded. Six new members have recently joined the club, while four old members have obtained their "A" licences.

YAPTON.
There are now eighteen members of the C.A.G. section who have reached the solo stage. The total flying time for last month amounted to 164 hr.

PLYMOUTH.
Although there were only three suitable flying days during the week ended April 25, 91 hr. were recorded. Mr. M. H. Tribe has gone solo. A successful house-warming cocktail party for the new building extension was held on April 22.

SOUTH COAST.
Over 78 hr. were recorded last week in spite of bad weather conditions. A large number of members and friends attended a dance held at the club last Saturday, when several members provided a most entertaining cabaret show. Mr. A G. Head has been engaged as assistant instructor.

BROOKLANDS.
Twelve machines took part in the "dawn patrol" last Sunday at Hanworth Seven of them got in undetected. Club members will take part in a similar event next Sunday at Portsmouth. Over 108 hr. were recorded last week Mr. F. Shirley-Fox has passed his assistant-instructor's tests.

WESTON.
Flying time for the week ended April 25 amounted to 70 hr. Mr. C. B. Payne has gone solo.

DONCASTER.
A total of 60 hr. was recorded last week. Messrs. Berman, Varley and Pugh have gone solo.

MARSHALL'S.
The flying time for the week ended April 28 amounted to 111 hr. 45 min.

PORTSMOUTH.
Last month C.A.G. members logged 152 hr. flying time. During the same period club flying amounted to 150 hr.

WEST SUFFOLK.
During last week club aircraft flew 22 hr. Miss A. Barber-Starkey and Mr. A. C Walker have gone solo.

THANET.
Club aircraft totalled 117½ hr. during the week ended April 25. Messrs. R. Morcom, W. F. Stone and N. E. Canton have gone solo.

EXETER.
Lt. Col Gedge has been appointed the club's C.A.G. organiser. Over 74 hr. were recorded during the week ending April 25. Messrs. R. E. Henson and R C Spiller have gone solo.

BORDER.
Bad weather conditions and increased R.A.F. activity somewhat handicapped flying last week. However, on two days two members went solo, while one passed his "A" licence tests.

REDHILL.
Flying time for last week amounted to 109 hr. The Misses E. N. Pittar and T. W. Whittall have gone solo. Mr. A. G. Douglas, one of the directors of the club, was married last Friday to Miss Ann C. Edmonds, secretary of the Surrey Gliding Club.

EASTBOURNE.
High winds and rain reduced the club's flying time last week to 60 hr. Mr T. C. Boulton has gone solo. Levelling operations are taking place in the field extending to the north of the aerodrome, and the telephone wires on the road running alongside have been removed.

Out of Retirement

THERE are many who maintain that the modern monoplane fighters, spectacular as they are when flown fast and low over the heads of a crowd, cannot compete with some earlier biplane types where aerobatic entertainment is concerned. Noise, of course, has some bearing on the matter, and the thunder of the Merlin is comparatively subdued as compared with the scream of the Kestrel.

There will be an excellent opportunity for making comparisons at the Royal Aeronautical Society's Garden Party at Heathrow on Sunday, May 14, for it is now announced that a Fairey Firefly is to be demonstrated, presumably by Flt. Lt. Staniland.

Modern Fairey types to be flown will be the Battle and the P4/34, and there are additions to the list of demonstrations of other aircraft given last week. Instead of a squadron of Hurricanes, twelve Spitfires will give a display—the spectacle should be impressive, for, as yet, we are accustomed to seeing these formidable fighters only in ones and twos. The new Reid and Sigrist trainer monoplane will be on view.

Four more firms have notified their intention of participating in the "static" show, making 37 in all.

A VERY REMARKABLE AEROPLANE

Details of the Handley Page Hampden Disclosed : Unusual Production Methods Based on "Split" Construction

(Illustrated with "Flight" Photographs and Drawings)

THE specialised experience of the Handley Page Company in the construction of multi-engined bombing aircraft is brilliantly reflected in the design of the Hampden monoplane, which for some months has been in quantity production for R.A.F. bomber squadrons. Not only is the Hampden an outstandingly efficient weapon, capable of high speeds, of long range and of carrying a heavy military load, but, thanks to its unorthodox design, would be well able to defend itself if intercepted by enemy fighters.

Ease of production and maintenance has not been sacrificed to military effectiveness. On the contrary, the Hampden is probably the easiest machine of its type in the world to build, owing to features which will be described here. Only by seeing the Hampdens in production at the Cricklewood works can one thoroughly appreciate the ingenuity of its design.

The Hampden is a three/four-seater mid-wing cantilever monoplane of all-metal construction. As at present in production it is powered with two Bristol Pegasus XVIII nine-cylinder radial engines fitted with two-speed superchargers.

When a crew of four is carried it consists of: (*a*) a pilot, who also operates the fixed gun; (*b*) navigator/bomber, who has charge of the front lower gun; (*c*) wireless operator, who is also the top rear gunner; and (*d*) a lower rear gunner.

The Hampden is unique among our multi-engined bombers in that it has no power-driven turrets, three of its four machine-guns being fired from a manually operated mounting, while the fourth is fixed.

The manœuvrability and the clear arcs of fire justify the makers in terming the Hampden a fighter bomber. On the occasion depicted, its agility was being demonstrated by Major Cordes. The photographic Hampden was piloted by Flt. Lt. J. R. Talbot.

The pilot's fixed gun is so arranged as to fire through a port in the nose just aft of the transparent section. Below this is a floor mounting for a machine gun which can be completely detached from its mounting and stowed in the fuselage. The top fuselage gun, which is set rather forward of the trailing edge of the wing, would be used mainly to fire aft between the twin rudders. The gunner who operates this weapon is shielded by a spring-loaded transparent dome. Located at the bottom rear corner of the fuselage "box," the lower rear gun has a particularly wide field of fire in a rearward and downward direction. The gunner is entirely within the fuselage, and the gun is easy to train without mechanical assistance.

A heavy load of bombs is carried in a bay in the bottom of the fuselage; additional bombs, carried in the "overload" condition, may be slung outboard of the engine nacelles under the wings. The bomb aimer (who is also the navigator) is situated in the extreme nose of the fuselage from which an exceptionally wide and clear view is obtainable. An optically flat circular Triplex panel is built into the nose section to facilitate bomb aiming.

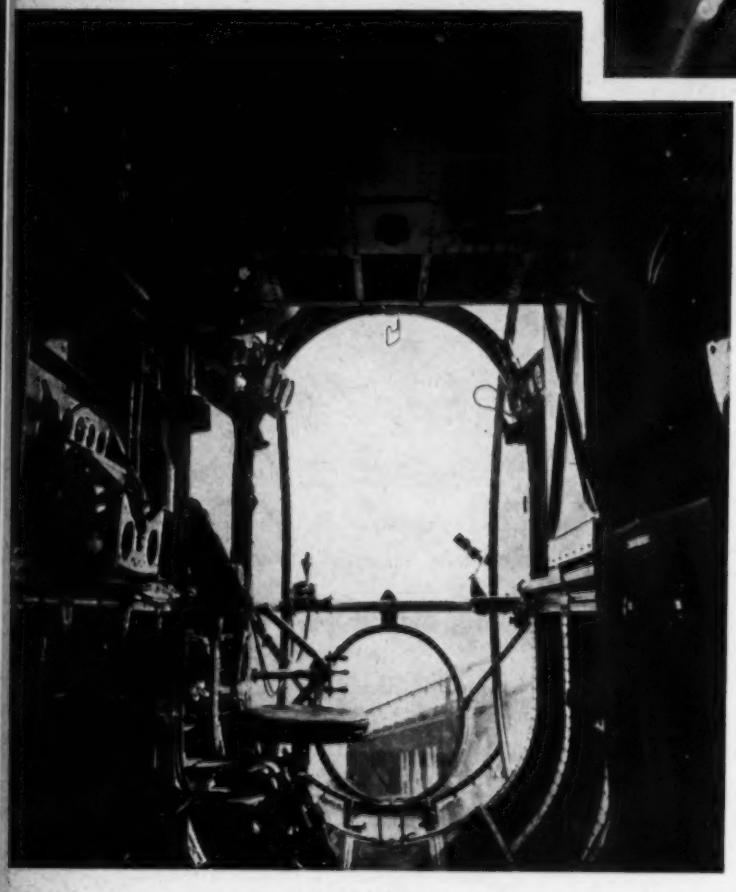
The Service load includes wireless, which is installed in the rear part of the top rear gunner's

A few of the Hampdens which are now leaving Radlett aerodrome in a nice steady stream for "unknown destinations."

station, and can be operated from the same seat; an automatic pilot; and an automatic camera, which is fitted immediately below the wireless set. Each member of the crew is provided with an exit to enable him to use his parachute.

The machine is fitted with the latest type of blind-flying and fog-landing equipment.

As at present in production, the Hampden is fitted with two Bristol Pegasus XVIII engines. The Pegasus XVIII is rated at 815 h.p. at 4,750ft., using medium supercharge, and



The compartment of the front lower gunner and bomber, in the nose of the fuselage (left) and, above, the unimpeded view obtained from it.

750 h.p. at 14,750ft. using full supercharge. The take-off output is 965 h.p., and the maximum power for all-out level flight (five minutes) is 1,000 h.p. at 3,000ft., or 885 h.p. at 15,500ft. Alternative engines of the Pegasus series (e.g., Pegasus XXV or XXVI) could equally well be installed. In any case, the engines would be fitted with the standard Bristol long-chord cowling embodying a leading-edge exhaust collector with single outlet and adjustable cooling gills on the trailing edge.

The Hampden could, alternatively, be equipped with in-line engines of liquid- or air-cooled type, notably the Rolls-Royce Merlin X (1,030 h.p. max. at 16,250ft. with two-speed supercharger in high gear) or the Napier Dagger VIII (1,000 h.p. max. at 8,750ft.). With the latter engines the machine is, in fact, built under the name Hereford by Short and Harland, of Belfast.

With Pegasus XVIII engines the Hampden is normally fitted with three-bladed De Havilland constant-speed airscrews.

If one were looking for proof of the contention that, provided the size of the initial order is sufficiently large, the rate of production can be greatly speeded-up by careful study of production problems during the design stage, such proof is furnished by the Hampden. The following notes, and a considerable proportion of the illustrations, are therefore devoted to the production aspect.

Assembly has always been the bottle-neck of production, whether it be the assembly of the innumerable "bits and pieces" of which a modern aircraft structure is composed, or whether it be the installation of the almost incredible range of equipment and "services" necessary for the proper functioning of a military aeroplane. That this must necessarily be so is obvious when one stops to consider that the manufacture of small parts and components can be speeded-up to any desired extent by multiplying the number of machines and operators; but when the various "bits and pieces" meet on the aircraft only a limited number of men can get to work on assembling them without getting in one another's way. So with the installation of equipment. Once the shell of a fuselage, for example, is completed, the number of men who can be accommodated inside for the purpose of mounting and connecting-up the instruments, armament, hydraulic and electric services, and so forth, in short, attend to "the plumbing," is obviously limited.

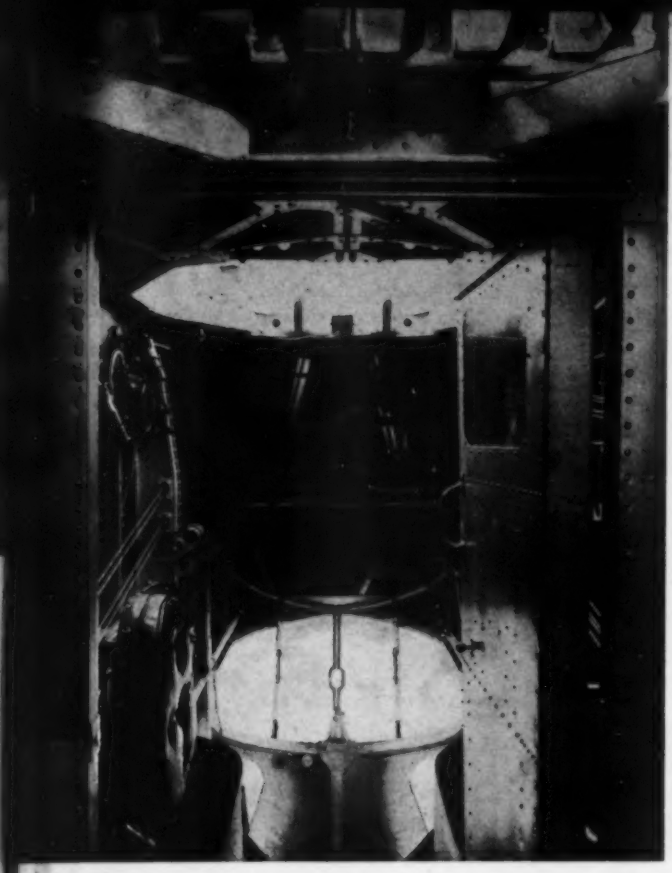
"Split" Construction

Realising this, the Handley Page Company decided, when the Hampden was being planned, to attack the problem in a different and more logical way. The aerodynamic design, as one may term it, once decided upon, the drawing office and the works got together, and, after a good many discussions, one may suppose, evolved the scheme on which the Hampden was ultimately produced. For its working this scheme is so completely dependent upon the closest co-operation between structural design and production that in the following notes the two must be dealt with concurrently.

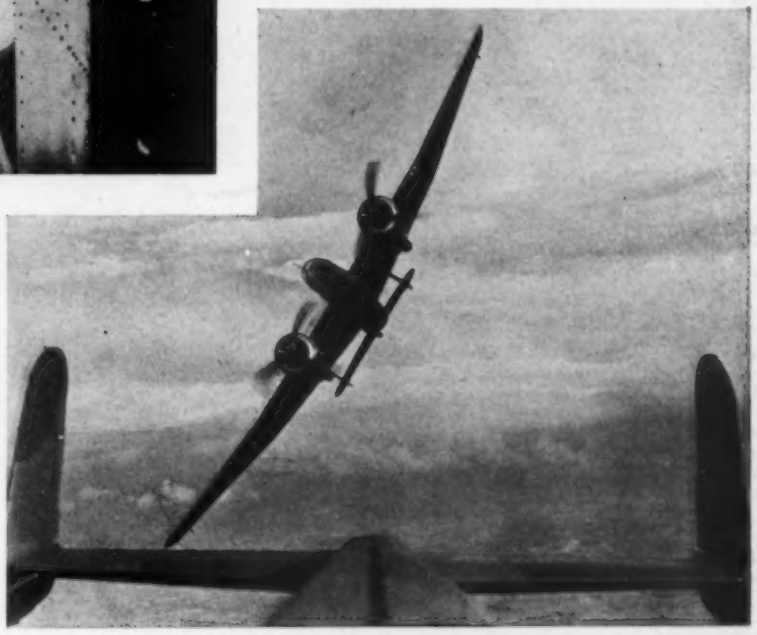
The foundation of the scheme was actually laid in connection with the previous Handley Page bomber type, the Harrow. When the initial order for Harrows was received it was, however, not of a size to justify very extensive jigging and tooling. Consequently, the scheme could not be carried to its logical conclusion, and a sort of half-way measure had to be adopted.

In the Hampden, however, the initial order was sufficiently large to justify much greater expenditure on jigs and tools, and consequently the principle could be carried almost to its logical conclusion. Not quite, because even the Hampden order was not sufficiently large to extend the desirable production methods down to the last small detail. However, the fundamental principle is there and can be applied to any type, so long as the size of order makes it financially possible.

An article on the flight-testing of Hampdens appeared in "Flight" of December 29, 1938.



There are two rear gun positions in the Hampden, an upper and a lower. How unhindered are the fields of view and fire obtained from them is shown in the pictures on the right. Major Cordes gives a good illustration of the Hampden as a fighter bomber.



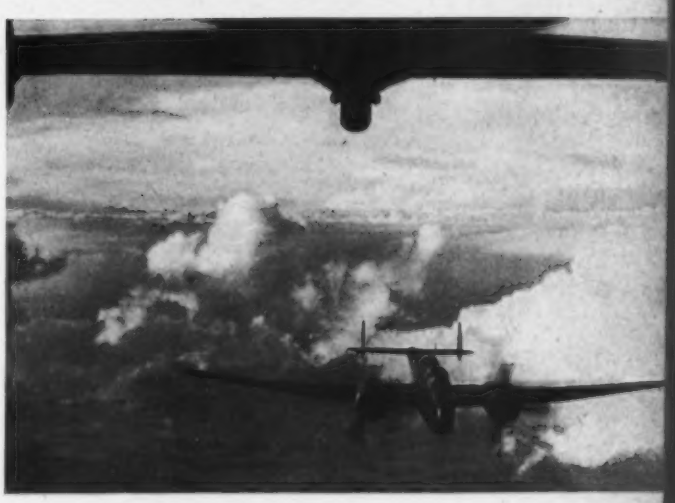
Briefly explained, it may be stated that the "theme" of the Hampden production is to adopt a "split" form of construction. This can best be illustrated by taking the fuselage as an example. Instead of building this in one piece, or in two at the most, the fuselage of the Hampden is divided first into three main parts, the front portion, the centre portion and the tail portion. The last two of these are again divided into two halves, with a vertical "split" down the centre.

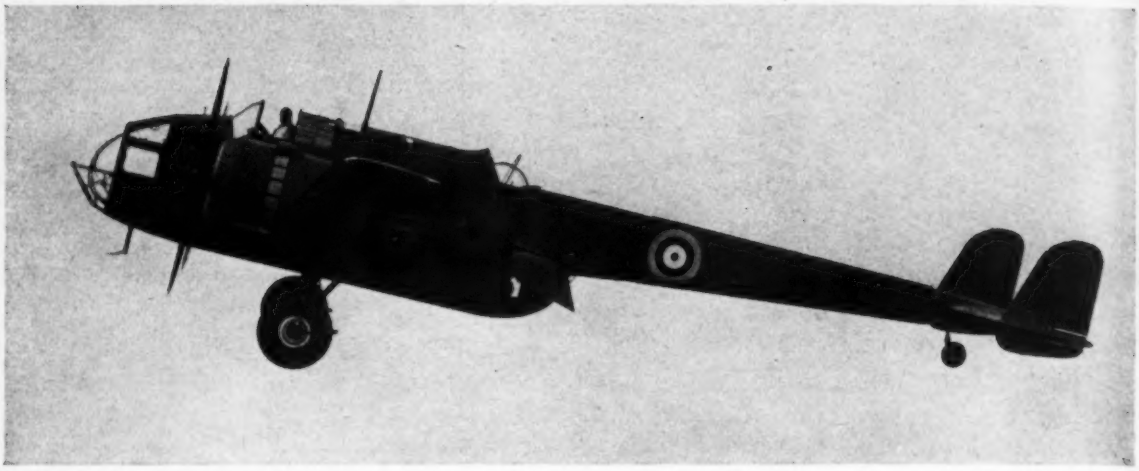
Three advantages result from this scheme. Actual assembly of the structure is facilitated, because by splitting the fuselage into two halves, a port side and a starboard side, riveting becomes an easy operation, as there are no inaccessible corners where holding up is difficult. A second advantage is that when equipment is being installed and electrical or hydraulic leads have to be run along, the men can stand up to the work in convenient positions, and there is never at any time any need for crawling about on hands and knees or lying down in order to get at some out-of-the-way piece of equipment or inaccessible pipe union. The third advantage is that complete interchangeability is ensured.

A somwhat similar scheme is followed in the construction of the wings. This consists of three main units: the centre section, the port outer wing and the starboard outer wing; but each of these is again sub-divided into smaller units, so that during assembly almost any desired number of men can be put to work by duplicating the number of units. Before the smaller units are assembled into larger units, some of the equipment and installation which goes in the wing is secured in place, so that when, finally, the larger wing units go together it is only a question of connecting up such leads, wires or controls as pass from one unit to the other.

In discussing the Handley Page Hampden type of construction, we have frequently met with the objection that, although the "split" type of construction may be very fine from a production point of view, it must of necessity entail extra structure weight. An examination of the Handley Page Hampden construction does not show any signs of such added weight, and actual figures disclose the interesting fact that the structural weight of the machine—that is to say, the airframe without engines—is only 32 per cent. of the normal gross weight. This figure actually includes a certain amount of structure which carries fixed equipment but which is not actually a part of the aircraft structure. There are probably few comparable machines which show such a good figure of airframe weight.

In its general structural design the Handley Page Hampden is of the usual stressed-skin type. That is to say, the external sheet metal covering carries part of the stresses and is reinforced by local stringers, frames, etc. Considerable use is made throughout the structure of extruded sections. In fact, these are





Controllability is but one of the many strong points of the Hampden. Here Major Cordes shows it "formating" at 65 m.p.h. with wheels and flaps down.

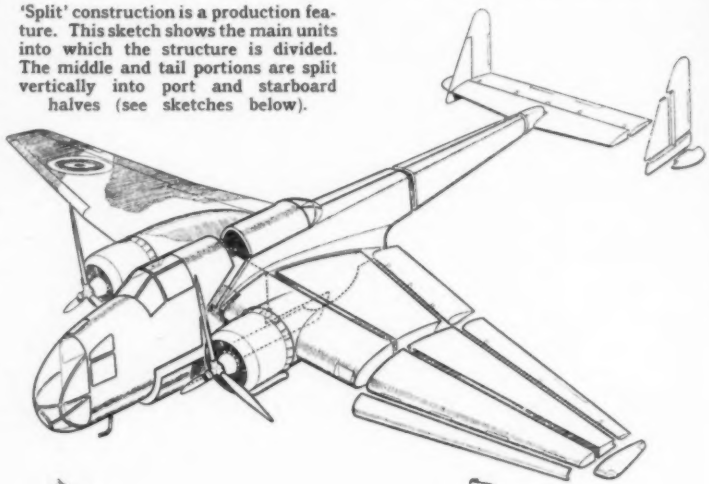
used wherever the gauge makes an extrusion economical. In the lighter gauges this would not be so, and there bent-up sheet metal strip is used instead of extrusions. Apart from their good mechanical properties, the use of extruded sections has the advantage that a good deal of work in the aircraft factory is saved. The drawback is, of course, the very obvious one that the aircraft constructor is entirely dependent on the manufacturer of extruded sections for his supplies. If there is any delay in delivery, the production in the aircraft manufacturer's shop is inevitably held up.

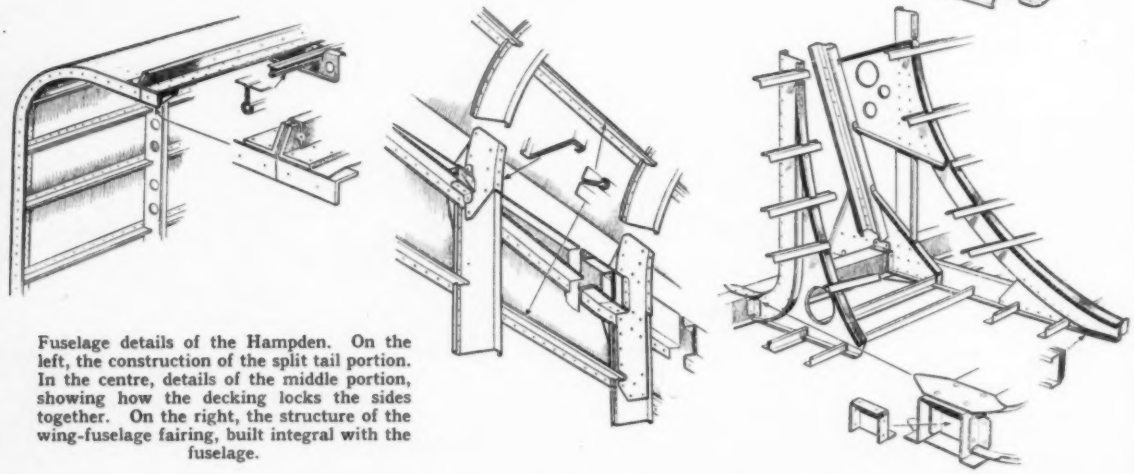
In these notes we do not propose to devote much space to the actual forming and manufacture of the small components. The usual processes are employed for pressing and drawing sections, and the Handley Page works do not differ materially from others in this respect. Where they are unique is in the system of assembly, and it is to this aspect that we propose to devote most of the space available.

The Fuselage

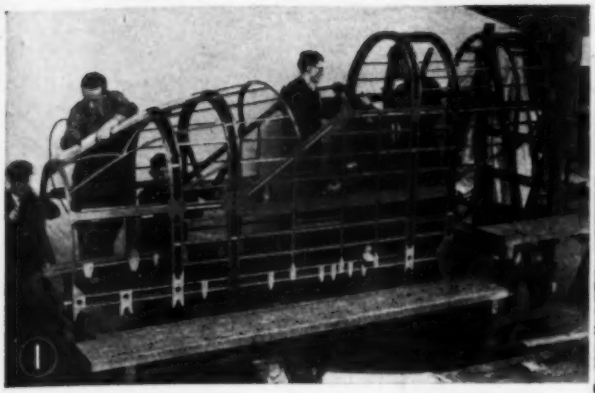
As already mentioned, the fuselage of the Hampden is made in three main units, of which the central and rear portions are again divided into two halves, port and starboard. The nose portion is not so divided, because during its assembly it is open at both ends and partly at the bottom, so that the men can get at the inside quite comfortably, and there was no real necessity to split it into two halves. The hoops, formers and stringers which compose its skeleton framework are manufactured in the shop, and the appro-

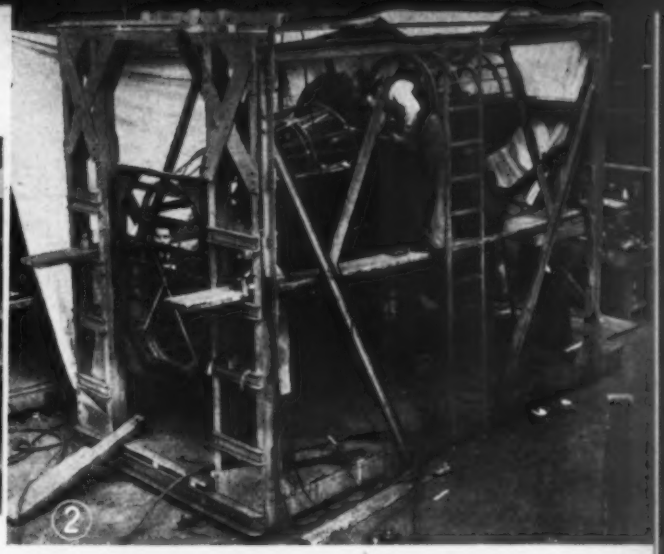
'Split' construction is a production feature. This sketch shows the main units into which the structure is divided. The middle and tail portions are split vertically into port and starboard halves (see sketches below).

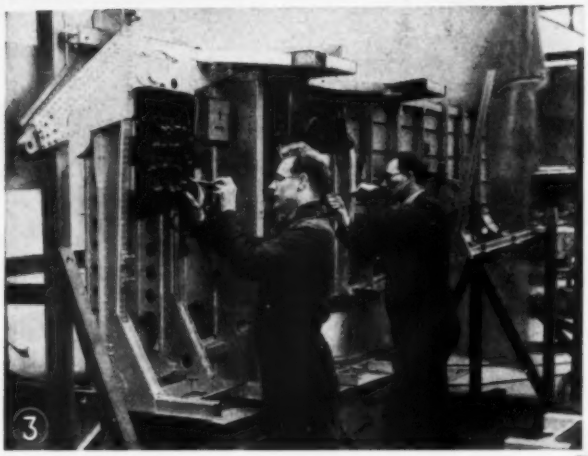


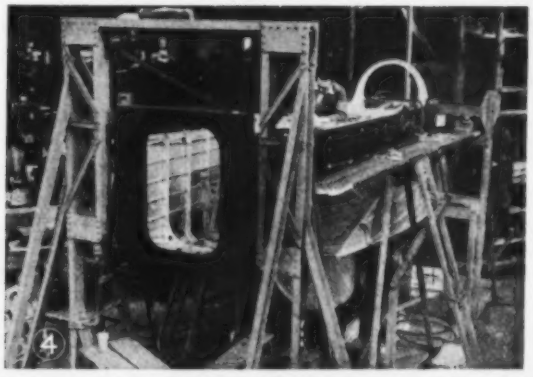


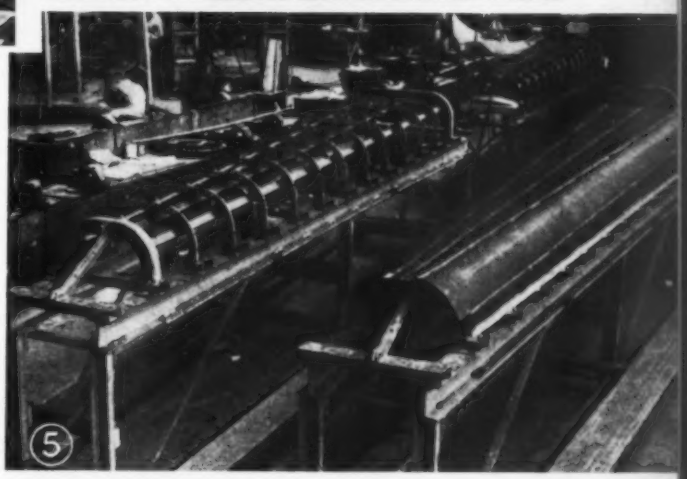
Fuselage details of the Hampden. On the left, the construction of the split tail portion. In the centre, details of the middle portion, showing how the decking locks the sides together. On the right, the structure of the wing-fuselage fairing, built integral with the fuselage.

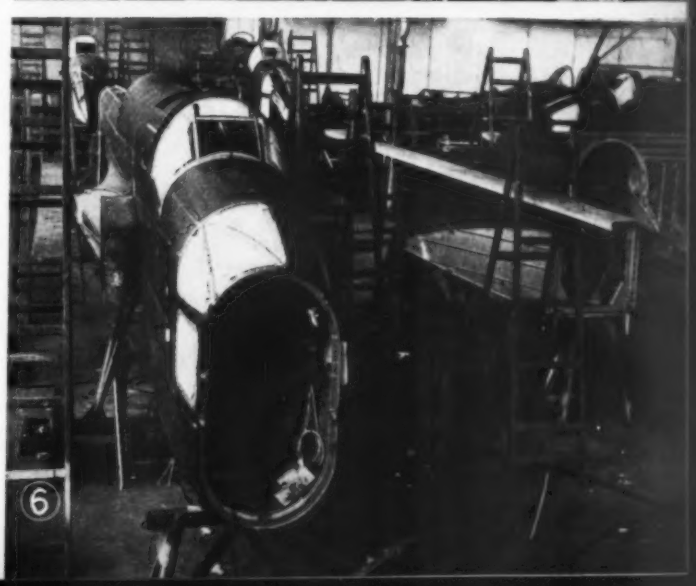










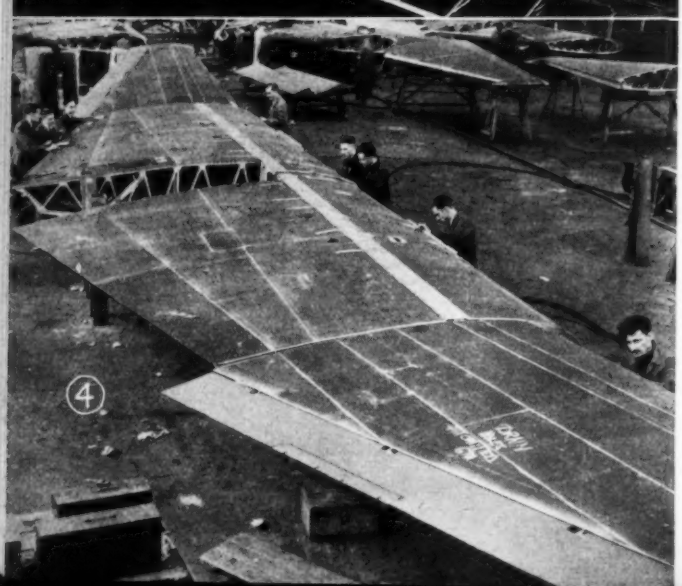


Production flow. These pictures illustrate the sequence of operations in building the Hampden fuselage. (1) The skeleton of the nose portion being assembled ; (2) after removal to a jig, the skin is riveted on ; (3) installing equipment in the starboard half of the centre portion ; (4) assembling the two halves of the centre portion in a special jig ; (5) the two halves of the fuselage tail portion are built on horizontal jigs, although the split is vertical ; (6) the three fuselage portions being brought together for assembly before transport to Radlett. The transparent nose unit is not yet in place.

priate members have attached to them the fishplates by means of which they are secured to other members. In this way there is no need for elaborate jigs on which to assemble the skeleton. In fact, this framework is assembled on plain wooden trestles, the fishplates providing sufficient indication of the angles at which adjoining members are to be attached. The same principle is applied throughout, and it is significant that one never sees a blue-print in the shops.

When the complete skeleton of formers and stringers has been riveted up, it is removed to large jigs built of structural steel. On these jigs the metal covering is applied. The main frames of the nose portion of the fuselage are built-up box-section members, whilst the intermediate frames are of Z-section. The lower longerons are large channels with the open side facing outwards, where the skin covering is attached to the turned-up flanges of the channel by riveting.

When the nose portion of the fuselage has been "skinned," as it is called (a horrible expression which seems to infer removing rather than applying the skin), it is taken to light wooden trestles where most of the equipment is installed before the nose portion is bolted to the centre portion of the fuselage. One of the last items to be attached is the transparent nose of the fuselage, which is a Perspex covering on a light tubular framework. The whole of this is made up as a unit and bolted to the fuselage when all the equipment, controls, etc., has been installed.



Growing wings : (1) the Hampden main spar in a horizontal drilling jig ; (2) the spar in the assembly jig, where it forms the basis of the whole centre-section ; (3) an outer wing having covering finished and ailerons attached ; (4) assembling centre and outer wing portions before dismantling them for transport to Radlett ; (5) installing leads and engine controls on front wall of spar box ; (6) assembling trailing-edge portions in their jigs ; (7) the engine installation jigs also have provision for assembling the undercarriage fully extended.

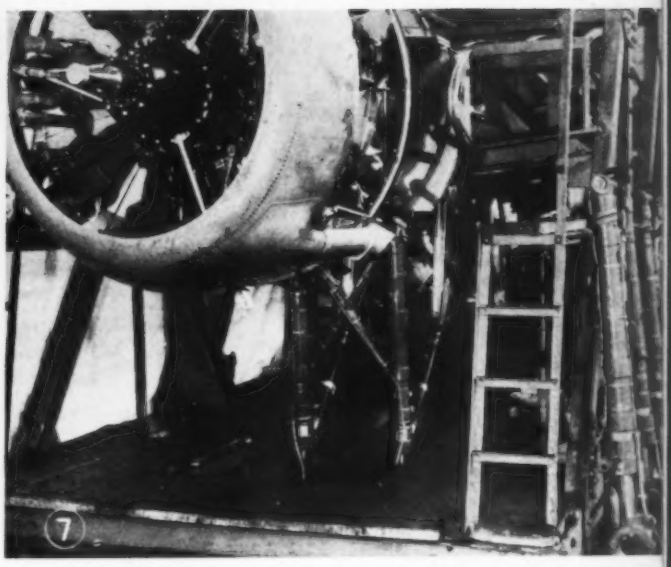
The middle portion of the fuselage is, as already mentioned, built in two halves, a port and a starboard. In the front part of this fuselage section the longerons are channel sections with a flat covering strip on the inside. In the rear part, however, the longerons are plain open channels, with the open side facing downwards. The main frames are of built-up box-section of light gauge, while the intermediate frames are of Z-section. The wing fairings of the centre-section are built integral with the centre portion of the fuselage. The skeleton of each half is assembled on trestles horizontally, and the riveting is done on very simple wooden jigs. When removed from the jigs these frameworks are, of course, very flexible, but when they are in place on the metal jigs in which the skin covering is applied they are held rigid and prevented from distorting. These large jigs each hold two fuselage halves, one port and one starboard.

Installing Equipment

Probably due largely to the fact that the wing root fairings are built integral with the fuselage halves, these are fairly stiff when they leave the jigs in which the "skinning" is done. Consequently, they deform but little when being removed from the main jig to be transferred to the light wooden jigs on which they rest while such items as wiring, piping and equipment are being installed.

It is here that, in following the process through at the Cricklewood works, one first begins to appreciate the cleverness of the type of production adopted for the Hampden. While a very few jigs serve for keeping pace with the skinning operation, many more may be needed for the installation of equipment. These simple wooden jigs, actually little more than slightly elaborated trestles, can readily be duplicated at very low cost, so that the installation of equipment can never form the "bottleneck" which it is likely to form with more orthodox methods of production.

Naturally, not all of the equipment can be installed while the central fuselage portion is in two halves. A certain amount, and such items as floors, etc., must necessarily be carried on transverse structure members. However, the percentage of equipment which has to wait until the two fuselage halves are joined together is relatively small.



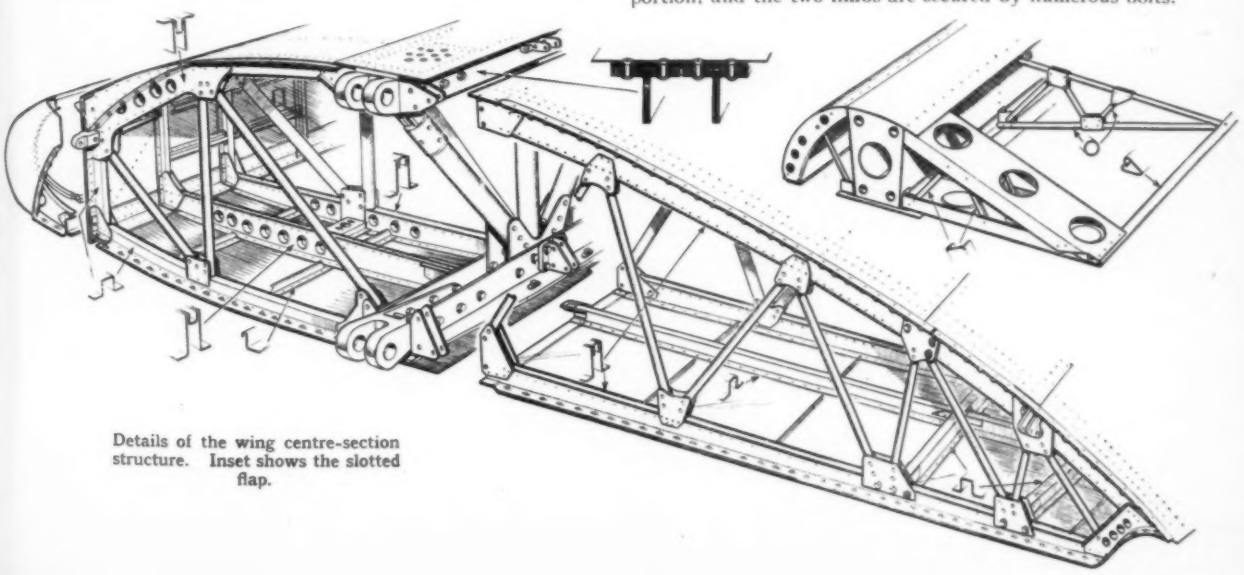
Fairly elaborate jigs built of structure steel are used for assembling the port and starboard portions of the fuselage. But only a small number of them is required, as the operation of joining the two halves together is not a lengthy one. In these jigs the cross-members are put in, and the butt joints of frames and formers are secured by fish-plates. The top of the fuselage is still open, and is covered, also in this jig, by a "lid" formed by the cambered top decking. In these jigs also the bomb "bay" is built on to the bottom of the fuselage, and the hinged doors attached, as well as the necessary wiring for the bomb-operating gear.

The Tail-carrying Boom

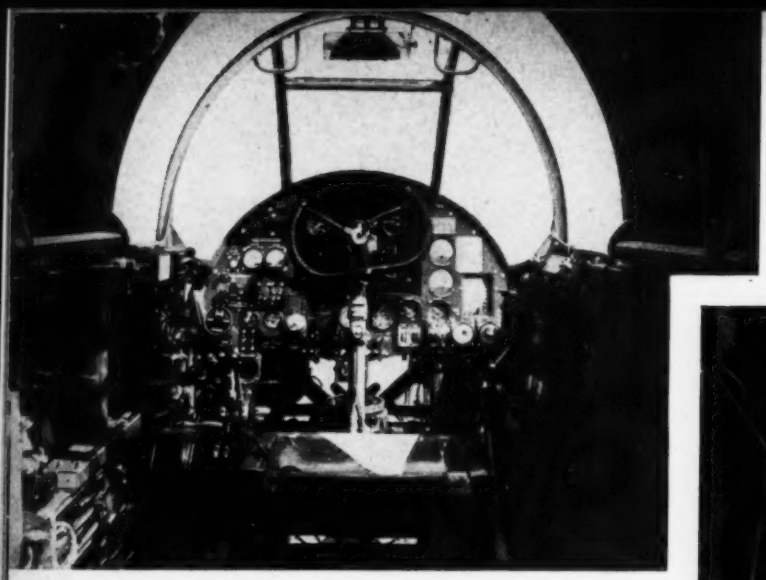
Elsewhere in the works the two halves of the fuselage rear portion have been manufactured. This portion of the fuselage is a very simple tapering tube with flat sides and rounded corners. It is "split" vertically like the middle portion of the fuselage, and has formers of simple Z-section and rather elaborate stringers, which can, perhaps, be described as being built up of two "Fig. 2" sections, of which the curl of one goes over the outside of the curl of the other (see sketch). The stringers, by the way, are joggled into the frames in order to provide smooth lines for the application of the skin.

The port and starboard halves of the tail portion of the fuselage have their frameworks assembled and skins attached on horizontal jigs. They are then transferred to an assembly jig, in which they are rigidly held by their ends while the joint between the two halves is being made. For the frames this joint takes the form of fish-plates, but for the skin a somewhat unusual system has been adopted. The "plank" nearest the joint is left slightly wide, and an L-section strip is riveted on the outside. The free edge of the skin plank is then turned up to lie along the vertical limb of the L-section. When the two halves are brought together in the jig, a strip of U-section is placed over the free edges and the whole riveted together. The process is extremely simple from the manufacturing point of view, and the only projections are the two U-section strips which run fore and aft and so probably add nothing appreciable to the air drag.

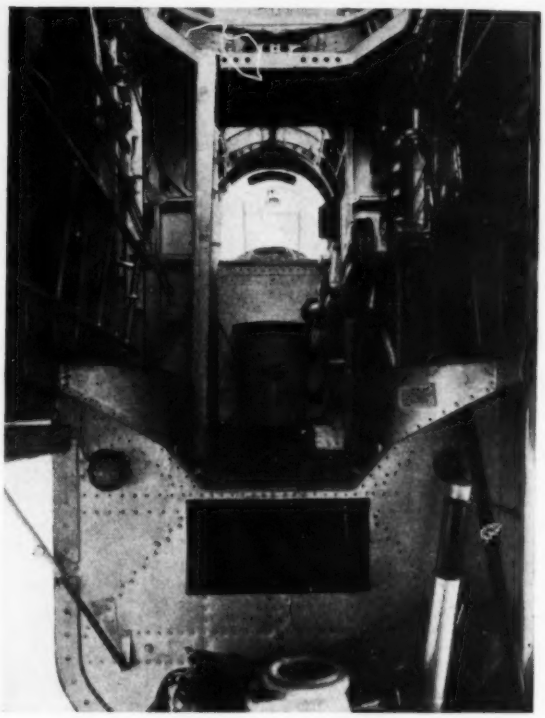
On their way down the shop the different fuselage portions gradually assume a more and more finished form until they finally meet at the far end, where the nose, middle and tail portions are brought together and joined. The joint between tail and middle portions is particularly simple. This is due to the fact that it occurs so far aft that there is no equipment to interfere, and a very straightforward joint can be made. The front end of the fuselage tail portion and the rear end of the middle portion have end frames of extruded L-section. One limb of each L is riveted to the fuselage skin. The other lies flat against the corresponding limb of the frame of the other fuselage portion, and the two limbs are secured by numerous bolts.



Details of the wing centre-section structure. Inset shows the slotted flap.



Two interiors which give some idea of the extensive equipment. On the left is the pilot's cockpit with dashboard and controls. Below is a view looking forward from the lower aft gun position. The top gunner's swivelling seat can be seen on the right.



The joint between middle and nose portions is of a totally different kind. Owing to the fact that much equipment, and certain highly stressed structure members, are involved at this point, it has been necessary to design a form of "four point mounting" with very substantial bolts and lugs for carrying the concentrated stresses at these points. On the other hand, the task of connecting and disconnecting the front or nose portion from the middle portion of the fuselage is greatly facilitated.

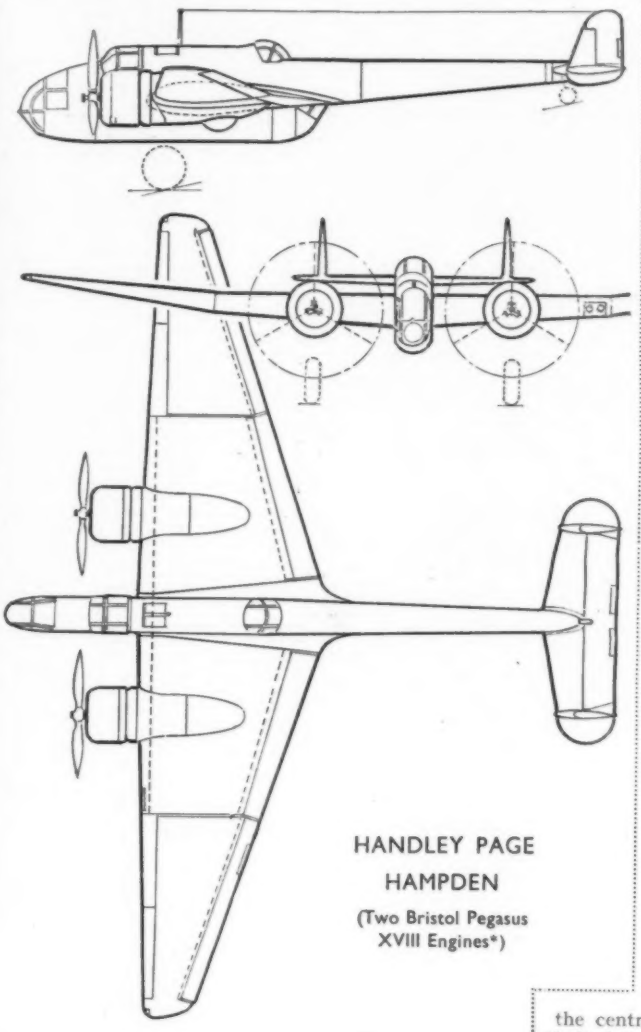
So carefully has been the jigging of the fuselage portions on their various stages that when the three main parts meet at the end of the shop, no jig is necessary for their assembly. The middle portion has inserted in the place where ultimately the wing centre-section will go a dummy undercarriage on which the fuselage is transported to Radlett. This dummy undercarriage forms the support while the fuselage is finally assembled and the few remaining items of equipment installed. When the last cover strip of the joints in the skin has been put in place, the fuselage, now complete, is wheeled into the dope shop.

In the construction of the Hampden wing the key member is the large single main spar. This takes all the bending loads, while sheer and torsion bracing is provided by the spar box and the stressed-skin covering. The main spar has flanges of built-up construction, consisting of two extruded T-sections placed side by side, a plain, heavy-gauge strip on top of the two Ts, and a thin sheet-metal covering strip which forms part of and serves as attachment for the rest of the sheet covering.

Generally the vertical and diagonal braces between spar flanges are duralumin tubes, but in places where concentrated stresses are found, or where certain components or equipment have to be attached to the wing structure, the braces are of built-up box-section. These sections are of very simple construction, consisting of two channels opposite one another, with the free edges turned outwards, and two flat strips on the other two sides. By this arrangement the lines of rivets are very accessible.

The spar "box" comprises a solid front wall or false spar, the rib channels and tubular braces. The box is, for ease of manufacture, built on to the centre-section main spar in five units. The trailing portion of the wing is of similar construction, but of lighter gauge material in view of the lower stresses in it. Instead of a false spar of

Two stages in the final assembly of wing and fuselage at the Radlett works. Note that the machine now rests on its proper undercarriage.



HANDLEY PAGE HAMPDEN

(Two Bristol Pegasus XVIII Engines*)

ordinary type, this portion of the wing terminates in a curved strip to form the fixed portion of the slot between flap and wing. The extreme leading edge is a trough of U-section, attached to the lower edge of the false front spar by "piano" hinges. It is built in short units. Not only does this form of construction facilitate access to the leads, engine controls, etc., carried on the front wall of the spar box, but in case of damage to a leading edge the chances are that only a short unit will need replacement.

Outer wing portions are of generally similar construction to the centre-section, with the exception that the main spar has a solid web, and flanges of extruded L-section. On their leading edges they carry the automatic slots, and on the trailing edges the Frise ailerons. Each outer wing portion is attached to the centre-section by four bolts; two large ones on the ends of top and bottom flanges of the main spar, one near the upper edge of the front spar wall, and one a short distance ahead of the junction of flaps and ailerons to the trailing edge. The two latter are quite light fittings, and almost the entire load is taken by the two very large bolted joints on the main spar flanges.

In order to "close" the spar box and to give access for inspection of the internal structure during the subsequent life of the machine, the under-surface of the wing has two straight (non-tapering) panels, about 8in. wide, running the entire span. These panels are located adjacent to the lower spar flange, and piano hinges are provided along one edge of each. Finally, the three main wing portions pass to the main assembly jig, in which they are bolted together and the interchangeability assured.

The production "flow" system may be described as a lateral inflow of small pieces from the different shops into two parallel longitudinal lines, one the fuselage components and the other the wing components. Owing to the "split" type of production one does not see anywhere in the works the familiar rows of finished or nearly finished fuselages and wings. When the three fuselage portions meet the centre-section at the far end of the shop, they are bolted together temporarily for transport by road to the works at Radlett aerodrome. There the fuselage is removed from the road chassis and finally assembled on the wing, resting on the proper undercarriage, which has been attached in the meantime.

At the Cricklewood works elaborate jigs are used for the assembly of the engine mountings. Each jig carries

Dimensions.

Length of fuselage	53ft. 4in. (16,25 *m.*)
Max. width of fuselage	3ft. (0,92 *m.*)
Max. height of fuselage	8ft. 8in. (2,65 *m.*)
Mean wing chord (aerodynamic)	11ft. 4in. (3,46 *m.*)
Root chord	16ft. 3in. (4,96 *m.*)
Tip chord	3ft. 10in. (1,17 *m.*)
Aspect ratio	6.58
Tailplane span	21ft. 2in. (6,45 *m.*)
Total wing area	668 sq. ft. (62,1 *m.*²)

Weights.

Tare weight	11 780 lb. (5 354 *kg.*)
Useful load	6,976 lb. (3 171 *kg.*)
Gross weight (normal)	18,756 lb. (8 525 *kg.*)
Distribution of load :—	
Fuel	3,173 lb. (1 442 *kg.*)
Oil	216 lb. (98 *kg.*)
Crew (4, with 5 parachutes)	
Service load (including crew)	3,587 lb. (1 631 *kg.*)
Max. fuel	654 gals. (2 975 *litres*)
Max. oil	36 gals. (164 *litres*)

Performance

(with Pegasus XVIII)

Max. speed at 18,750 lb. gross weight :
265 m.p.h. (427 *km./h.*) at 15,500ft. (4 730 *m.*)
Cruising speed at normal r.p.m. :
217 m.p.h. (350 *km./h.*) at 15,000ft. (4 580 *m.*)
Economical cruising speed :
167 m.p.h. (269 *km./h.*) at 15,000ft. (4 580 *m.*)

Service ceiling	22,700ft. (6,920 *m.*)
Time to 15,000ft. (4,580 *m.*)	18.9 minutes
Sea level rate of climb	980 ft. min. (4.98 *m/sec.*)
Take-off run to clear 50ft. barrier	550 yds. (503 *m.*)
Landing run, clearing 50ft. barrier	550 yds. (503 *m.*)
Landing speed	73 m.p.h. (117 *km./h.*)

Service Load and Range.

Load		Range: Normal Cruising Speed		Range: Economical Cruising Speed	
lb.	*kg.*	miles	*km.*	miles	*km.*
2,587	1 176	1,475	2 380	1,790	2 880
3,587	1 631	1,095	1 760	1,335	2 150
5 587	2 540	360	580	440	710

Performance at Max. Permissible Wt. of 21,000 lb. (9 550 kg.)

(At 15,000ft. (4 580 *m.*)

Cruising speed	212 m.p.h. (341 *km./h.*)
Economical speed	172 m.p.h. (277 *km./h.*)
Service ceiling	19,500ft. (5 950 *m.*)
Time to 15,000ft.	27.2 minutes
Sea level rate of climb	760 ft./min. (3.87 *m./sec.*)
Take-off run to clear 50ft. barrier	810 yds. (741 *m.*)

Service Load and Range.

Load		Normal Cruising Speed		Economical Speed	
lb.	*kg.*	miles	*km.*	miles	*km.*
3,587	1 631	1,725	2 780	1 990	3 210
5,587	2 540	1,165	1 875	1,340	2 160
6,587	2 994	788	1 270	870	1 400

* Alternative Power Plants are the Napier Dagger VIII and the Rolls-Royce Merlin X.

two mountings, back to back, and all the engine equipment which goes in the mounting unit is installed there. The undercarriages are also assembled on these jigs, pits in the concrete floor of the shop permitting of the undercarriage being fully extended for test.

One feature of the Handley Page works system which deserves mention is that nowhere does one see a blueprint. Presumably they were used when production first started, but by now the men have become so accustomed to the work that they do not need drawings to guide them. This obviously saves a good deal of time.

The type of production adopted at Cricklewood could equally well be introduced elsewhere. For example, there does not appear to be any reason why, if Hampdens are wanted in larger quantities than the parent firm can produce, the great shipbuilding concerns should not undertake the work. Handley Page, Ltd., have had to train a large percentage of their workers, and the shipbuilding firms could do the same. Already something of the sort is taking place in that the English Electric Company, Ltd., by arrangement with Handley Page, Ltd., and the Air Ministry, is building the Hampden at Preston. In Canada the machine is to be built by the Canadian Central Aircraft Corporation.

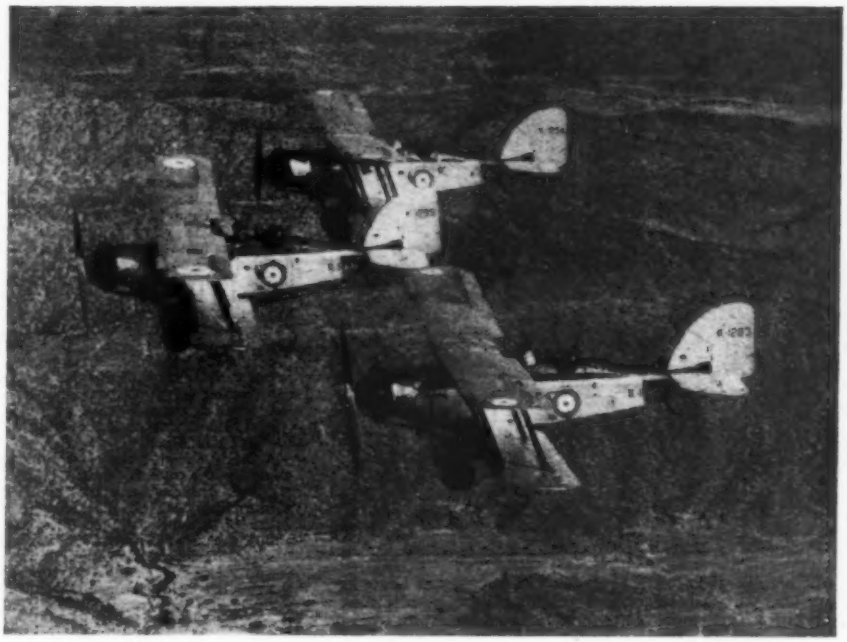
SOME CONTRIBUTORS to the HAMPDEN'S CONSTRUCTION

Accles and Pollock, Ltd.: Steel tubes.
Aerograph Co., Ltd.: Spray guns, etc.
Aerostyle, Ltd.: Spray equipment.
Aircraft Components, Ltd.: Wheels, undercarriage equipment, etc.
Aircraftings, Ltd.: Aircraft cocks.
Geo. H. Alexander (Machinery), Ltd.: Marking presses.
Edgar Allen and Co., Ltd.: Tipped tools.
Alley and MacLellan, Ltd.: Electric motors.
Aluminium Corporation, Ltd.: Aluminium sheets.
F. B. Andre and Co.: "Floatex" bearings.
Andrews Toledo, Ltd.: Steel.
Jas. Archdale and Co., Ltd.: Production machines.
Arens Controls, Ltd.: Arens controls.
Sir W. G. Armstrong-Whitworth, Ltd.: Machines and parts.
Arnott and Harrison, Ltd.: Tools.
Aviation Developments, Ltd.: Rivets.
Automotive Engineering Co., Ltd.: Circlips.
Automotive Products, Ltd.: Hydraulic equipment.
Avimo, Ltd.: Standard couplings.
Bakelite, Ltd.: Bakelite sheets.
B B. Chemical Co., Ltd.: Bostik cement.
Baldwins, Ltd.: Tinned steel.
Barber and Colman, Ltd.: Shakeproof screws
Barrow, Hepburn and Gale, Ltd.: Leather straps.
J. E. Baty, Ltd.: Gauges.
Baxters (Bolts, Screws, Rivets), Ltd.: Rivets.
J. Beardshaw and Son, Ltd.: Steel sheet.
G. Beaton and Co.: Pressings.
Becket, Laycock and Watkinson, Ltd.: Beclawat channels.
Bell's Asbestos and Engineering Supplies, Ltd: Asbestos sheet parts, etc.
Bifurcated Tubular Rivet Co., Ltd.: Rivets.
Birmetals, Ltd.: Aluminium bar, sheet, etc.
Birmingham Aluminium Castings Co., Ltd.: Magnesium alloy castings.
Birmingham Tool and Gauge Co., Ltd.: Spigots, rose cutters, rivets, etc.
Blackburns (London), Ltd.: Copper tubing, copper wiring, brass, etc.
Bloctube Controls, Ltd.: Bloctube fittings.
D. H. Bonnella and Sons, Ltd.: Cable sleeves and rings.
Jas. Booth Co., Ltd.: Aluminium alloy bar, wire, tube, copper, etc.
Bowden (Engineers), Ltd.: Cable.
Boyriven, Ltd.: Upholsterer's solution
Briggs Motor Bodies, Ltd.: Frame-members.
British Aluminium Co., Ltd.: Aluminium tube, sheets, strip, etc.
British Celanese, Ltd.: Novellon, Celastoid.
British Ebonite Co., Ltd.: Ebonite.
British Insulated Cables, Ltd.: Ducel, Unicel, Tricel, etc.
British Oxygen Co., Ltd.: Welding equipment.
British Thomson-Houston, Ltd.: Electrical equipment.
Brooke Tool Manfg. Co., Ltd.: Small tools.
Broome and Wade, Ltd.: Drills, etc.
Brown Bros. (Aircraft), Ltd.: Accessories.
Bruntons, Ltd.: Swaged rods.
Buck and Hickman Ltd.: Tools.
Buncher and Hasler, Ltd.: Spinnings.
Burley, Ltd.: Rubber strip, etc.
J. Burns and Sons, Ltd.: Fibre parts, fairleads, washers, etc.
Burton, Griffiths and Co., Ltd.: Small tools.
Cambridge Instrument Co., Ltd.: Pyrometers.
W. Canning and Co., Ltd.: Plating equipment.
Jas. Gartland and Son, Ltd.: Special bolts, aluminium piano hinges, door catches, etc.
Central Chemicals, Ltd.: Casein cement.
J. Christopher and Sons: Trolley wheels.
W. T. Clark and Co., Ltd.: Spinnings, circular window frames.
Consolidated Pneumatic Tool Co.: Riveting guns.
Corfield and Buckle, Ltd.: Blanks and pressings.
Cork Mnfg. Co., Ltd.: Langite washers.
Cornercroft, Ltd.: Gauges.
R. E. Cotes, Ltd.: Saws, screws, blades, etc.
Coventry Tool and Gauge Co., Ltd.: Snaps and blocks, rivets, squeezers, springs.
Craig and Donald, Ltd.: Guillotine blades.
C.V.A. Jigs, Moulds and Tools, Ltd.: Tools.
Dashwood and Partners, Ltd.: Insulator sleeves, hooks, links, etc.
Davis and Timmins, Ltd.: Brass screws.
De Bergue Patents, Ltd.: Rivets, riveting machines and tools.
De Havilland Aircraft Co., Ltd.: Airscrews.
Deloro Smelting and Refining Co., Ltd.: Stellite tool tips.
Delta Metals Co., Ltd.: Bronze, brass, etc.
Desoutter Bros.: Drills.
Dexine, Ltd.: Dexine fairleads, etc.
W. B. Dick and Co., Ltd.: Anti-freezing grease.
Dunham White and Co., Ltd.: Lead seals.
Dunlop Rubber Co., Ltd.: Wheels.
Ealing Park Foundry, Ltd.: Castings, etc.
Edison Swan Electric Co., Ltd.: Bulbs.
F. J. Edwards, Ltd.: Swaging machines, presses, etc.
Ellison Insulation, Ltd.: Tufnol parts.
Enfield Rolling Mills, Ltd.: Zinc foil.
English Electric Co., Ltd.: Coupling sleeves, carbon bushes.
Everett, Edgecumb and Co., Ltd.: Electrical parts.
Ever-Ready Co., Ltd.: Batteries, torches.
Expanded Metal Co., Ltd.: Expanded metals.
Expanded Rubber Co., Ltd.: Rubber.
Farmer, Stedall and Co.: Grinding wheels.
Fescol, Ltd.: Fescolising.
Thos. Firth and J. Brown, Ltd.: Small tools.
Firth-Vickers Stainless Steels, Ltd.: Steels.
C. J. Fitzpatrick and Co.: Bevel gears, worm wheels.
W. T. Flather and Co.: Steel.
Fry's Metal Foundries, Ltd.: Solder.
John Fraser and Son, Ltd.: Salt baths, etc.
Gallay, Ltd.: Aircraft heating apparatus.
Gaston E. Marbaix, Ltd.: Riveter.
General Electric Co., Ltd.: Lighting equipment.
Gillett, Stephens, Ltd.: Machined parts.
F. Gilman (B.S.T.), Ltd.: Flexible-drive tools, etc.
Gittings and Hills, Ltd.: Enamels, etc.
Goodman Industries, Ltd.: Tools and parts.
Grey and Martin, Ltd.: Silver solder.
J. J. Habershon and Sons, Ltd.: Steel.
Hall and Hall, Ltd.: Washers, fabric, etc.
Harrison and Sons, Ltd.: Cornered steel grit.
G. A. Harvey and Co.: Pressings, corrugated sheets, etc.
T. P. Headland, Ltd.: Drill chuck keys, sleeves, chasers, snips, screwdrivers, etc.
Heaton and Duggard, Ltd.: Single- and double-link chains.
C. E. Heinke, Ltd.: Tubing.
Held Glue and Compounds Co., Ltd.: Heldite jointing.
W. T. Henley's Telegraph Works, Ltd.: Soldering irons, insulation tape, etc.
R. Heppelthwaite, Ltd.: Machined parts.
Alfred Herbert Co., Ltd.: Small tools.
High Duty Alloys, Ltd.: Alloy, strips, slabs, stampings, etc.
Hoffman Mfg. Co., Ltd.: Ball bearings.
Hofman Tool and Engineering Co.: Tools and parts.
Hogget, Young and Co., Ltd.: Acetylene-welding equipment.
H. C. Hopper, Ltd.: Cast-iron castings.
F. A. Hughes and Co., Ltd.: Acids.
Hughes, Johnson Stamping Co., Ltd.: Steel stampings, forgings, etc.
Hyde and Co., Ltd.: Engraver's wax, etc.
Hypower, Ltd.: Pressings.
I.C.I. Plastics, Ltd.: Perspex panels.
Impervia, Ltd.: Rubber, rubber hose.
Improved Liquid Glue Co., Ltd.: Glue.
India Rubber and Gutta Percha, Ltd.: Rubber solution, tapes, strips, etc.
Integral Auxiliary Equipment Co.: Pumps.
C. E. Johansson, Ltd.: Small tools.
Johnson and Phillips, Ltd.: Switches, bobbins, coils, etc.
A. A. Jones and Shipman, Ltd.: Belts, coil springs, pulleys, etc.
E. H. Jones (Machine Tools), Ltd.: Machines and tools.
T. C. Jones and Co., Ltd.: M.S. bar, cast iron, channel, angle iron, etc.
C. H. Joyce, Ltd.: Index plates, etc.
Kautex (Plastics), Ltd.: Sealing rings, sealing gaskets.
Kirby's Refineries, Ltd.: Lard oil.
Lapointe Machine Tool Co., Ltd.: Broaching parts.
Leverstart, Ltd.: Machine parts.
Leytonstone Jig and Tool Co.: Tools and parts.
Lion Engineering Co., Ltd.: Pins, hinges, etc.
Lockheed Hydraulic Brake Co.: Tube adaptors, tube nuts, pipe connectors, etc.
London Name Plate Manfg. Co.: Labels.
J. Lucas, Ltd.: Mirrors, Lucas horns.
MacReady's Metal Co., Ltd.: Black and bright mild steel.
Manganese Bronze and Brass Co., Ltd.: Oilite bushes, brass bar.
Metal Moulding, Ltd.: Sections.
Mitchell Bros., Ltd.: Washers, felt strip, etc.
Mollart Engineering Co., Ltd.: Bearings, ball joints.
C. D. Monninger, Ltd.: Metal-cutting band-saws, steel bar, etc.
Morrison, Marshall and Hill: Band-saws, feed attachment, brazing attachment, etc.
Herbert Morris, Ltd.: Chain tackle, etc.
Mouldrite, Ltd.: Perspex, Perspex panels.
M.R.C., Ltd.: Controls.
Nettlefold and Sons, Ltd.: Wood screws, cowling screws, bolts to drawing, etc.
J. C. Nicklin, Ltd.: Steel sheets, tinned steel.
Northern Aluminium Co.: Aluminium alloy strip, strip, extruded bar, etc.
S. E. Opperman, Ltd.: Winch screws, geared nuts, worm shafts, etc.
Palmer Tyre, Ltd.: Springs, sleeves, washers, clips, spanners, cover plates, levers, valves, etc.
Petroflex Tubing Co., Ltd.: Tubing.
Philco Radio Corporation: Tools and parts.
Phosphor Bronze Co., Ltd.: Phosphor bronze, balls, wire, etc.
Phillips Industrial, Ltd.: Welding rods, etc.
Phœnix Telephone and Electric Works: Cables.
Pinchin, Johnson and Co., Ltd.: Metal-marking paint, varnish, etc.
Wm. Pinchin and Co., Ltd.: Resin.
F. W. Potter and Soar, Ltd.: Brass and steel gauze.
Power Flexible Tubing Co., Ltd.: Tubing, hose.
Pressed Steel Co., Ltd.: Pressings.
Ransome and Marles, Ltd.: Bearings
Ratcliffe Tool Co., Ltd.: Tools and parts

(*Concluded on p. 466.*)

SERVICE AVIATION

Royal Air Force and Official Announcements : Fleet Air Arm News : Military Aviation Abroad



OLD SOLDIERS . . . "A" Flight of No. 27 (Bomber) Squadron, stationed at Kohat, N.W. Frontier Province, snapped while on a bombing raid into Warizistan last February. The machines are Westland Wapitis. The Wapiti is one of the best-loved aircraft ever to be used by the R.A.F.

Long-range Flight Rewards

HIS MAJESTY THE KING, it is announced, has been graciously pleased to approve of the undermentioned rewards in recognition of services rendered in connection with the Long-range Development Unit, which flew non-stop from Ismailia, Egypt, to Port Darwin, Australia, on November 5-7, 1938, establishing a world's long-distance record:—

(a) *To members of the aircraft crews*:—

AIR FORCE CROSS.—Sqn. Ldr. R. Kellett; Sqn. Ldr. A. N. Combe; Sqn. Ldr. B. K. Burnett; Flt. Lt. R. T. Gething; P/O. M. L. Gaine.

AIR FORCE MEDAL.—Sgt. H. B. Gray.

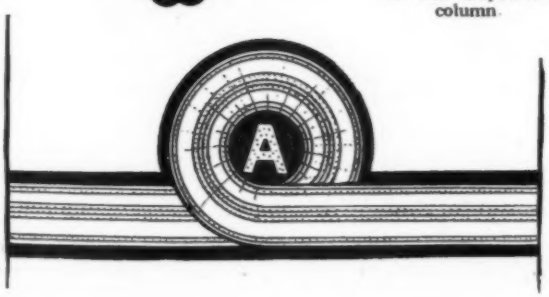
(b) *To the Royal Australian Air Force Liaison Officer attached whilst in Australia*:—

AIR FORCE CROSS.—Flt. Lt. P. G. Heffernan.

The Long-range unit was officially formed in January, 1938, at Upper Heyford. In view of his previous specialised experience, Wing Cdr. O. R. Gayford, D.F.C., A.F.C., was placed in charge of the Unit. On July 7, 1938, four Wellesleys of the Unit completed a flight from Cranwell to Ismailia via the Persian Gulf, a distance of 4,300 miles, in approximately 32 hours. They returned direct to Upper Heyford on July 21, covering the distance of 2,300 miles in approximately 16 hours. The Unit returned to Ismailia on October 25.

Three Wellesleys of the Unit left Ismailia (Egypt) at dawn on November 5, and, following the Great Circle Route to the East, reached Koepang (Timor) on November 7, covering the distance of 6,658 miles and thus breaking the world's non-stop flight record. No. 2 aircraft was forced to descend at Koepang owing to shortage of fuel but the others reached Darwin (Australia) having covered a total distance of 7,158 miles non-stop. The flight was recently homologated by the F.A.I. as a world record.

The Unit was disbanded last January.



The new Fleet Air Arm pilot's badge (left) and R.N. and R.N.V.R. Air Branch badge (below) referred to in the adjacent column.

Empire Air Day Programme

THE Secretary of State for Air, Viscount Trenchard, Air Chief Marshal Sir Cyril Newall; A.V-M. C. F. A. Portal; Lt. Col. Sir Francis C. Shelmerdine; and the High Commissioners of the Dominions; these are among the distinguished contributors to this year's programme for Empire Air Day. The magazine section has been enlarged to commemorate the coming-of-age of the R.A.F. At sixpence the programme gives a very fair outline of the work and importance of the Service.

The Lysander II

THE Bristol Perseus XII 9-cyl. sleeve-valve engine is the standard power plant of the Westland Lysander II army co-operation monoplane now in service in the R.A.F. This unit is rated at 745 h.p. at 6,500ft. and gives a maximum power for all-out level flight (5 min.) of 905 h.p. For take-off 830 h.p. is available.

The performance of the Lysander II approximates to that of the Mark I version fitted with a Mercury XII poppet valve engine. In comparison with the earlier type, the Mark II machines will be much easier to maintain thanks to the simplicity of the sleeve-valve unit.

F.A.A. and Air Branch Badges

HIS MAJESTY THE KING has been pleased to approve the design of badges for officers qualified as Fleet Air Arm pilots and for Air Branch officers of the Royal Navy and Royal Naval Volunteer Reserve. The former badge is to be worn by all officers (whether of the Executive, Engineer, or Air Branch, and by Royal Marine Officers) who have qualified as F.A.A. pilots. The latter badge is to be worn by all officers of the Air Branch, R.N. and R.N.V.R.

The pilot's badge, which consists of wings of gold embroidery having in their centre a silver anchor, surrounded by a wreath and surmounted by a crown, is to be worn by officers as soon as they have qualified for "wings" at their F.T.S. It is to be worn—in the case of blue uniform or khaki Service dress—on the sleeve in the case of naval officers, and on the breast by Marine officers.

The Air Branch badge is a capital letter "A" in gold embroidery, to be worn inside the circle on the uppermost ring of the distinction lace, or in a corresponding position in the case of officers who do not wear the circle. It is worn on both sleeves and on both shoulder straps.

Service Aviation

DIPLOMATIC JOY-RIDE : Looking thoroughly at home in flying kit, M. Gafencu, the Rumanian Foreign Minister, emerges from a Blenheim after a flight at Hornchurch, where he inspected a number of Service types last week.

"P.T." at Olympia

THE Royal Air Force Physical Training School, Uxbridge, is preparing a delightful show for the Royal Tournament, starting at Olympia on May 18. Flt. Lt. A. F. Ingram is in charge and the detachment will comprise 100 men from No. 1 R.A.F. Depot. The exercises will demonstrate the possibilities of exercising every muscle in a short space of time.

No. 62 (Bomber) Squadron Reunion

IT is proposed to hold the first annual reunion dinner of past and present officers of No. 62 Squadron R.F.C. and R.A.F. on Saturday, May 13, at the Royal Air Force Club, Piccadilly, at 7 p.m. for 7.30 p.m. The price of tickets will be 18s. 6d. each (inclusive of cocktails, wines, etc.). Dinner jackets, without decorations, will be worn. Officers wishing to attend should communicate, forwarding remittances, with F/O. C. H. Boxall, No. 62 (B) Squadron, Royal Air Force Station, Cranfield, Bletchley, Bucks.

Bertrand Stewart Prize Essay

THE subject for the Bertrand Stewart Prize Essay for 1940 is as follows: "A quotation from Mahan reads: 'If time be, as is everywhere admitted, a supreme factor in war, it behoves countries whose genius is essentially not military, whose people, like all free people, object to paying for large military establishments, to see to it that they are at least strong enough to gain the time necessary to turn the spirit and capacity of their subjects into the new activities which war calls for.' Discuss this statement and, in so far as the British Empire is concerned, suggest how, within the limitations of the present constitution, the man-power resources of the Empire can best be utilised at the outbreak and in the early stages of hostilities."

Flying Accidents

THE Air Ministry regrets to announce the following accidents:—

Sgt. Sidney Victor Evetts (flying solo) lost his life in an accident to an aircraft of No. 56 Squadron near Chelmsford, Essex, on April 24.

F/O. David Roderick Hopper (pilot) and F/O. Derek Leslie Rea Hutchinson (Captain, Royal Tank Corps), lost their lives in an accident which occurred at Koubbeh, Egypt, on April 27, 1939, to an aircraft of No. 208 Squadron.

F/O. Denys Greville Bell (flying solo) lost his life in an accident which occurred at Denham, Buckinghamshire, on April 28, 1939, to an aircraft of No. 13 Squadron.

F/O. Ronald Anthony George Petrie (pilot) and A/C.2 Henry Arthur John Stacey lost their lives in an accident which occurred near Folkestone, Kent, on April 28, 1939, to an aircraft of No. 2 Squadron.

The Air Ministry Buys Flamingos

FOR some time it has been known that the Air Ministry is interested in the D.H.95, and last Monday Capt. Balfour, the Under Secretary of State for Air, replying to a question by Sir Lindsay Everard, said that his department was "placing an order for a number of D.H. Flamingo type liners adapted to fulfil part of the transport requirements of the Royal Air Force."

Although the maximum capacity normally given for this machine is twenty passengers, it is worth knowing that twenty-three or twenty-four can be accommodated over ranges shorter than 1,000 miles, even with full civilian comfort. Presumably this number of troops, with their equipment, could equally easily be carried. For a 400-mile range at 210 m.p.h. the 95 actually has a payload of 3,817 lb.; the figure for 600-mile range is 3,325 lb.

The R.A.F. in Action

DURING December it was reported that a section of the Audhali Tribe, known as the Ahl Am Sha'a, were harbouring a Yemeni who was thought to be guilty of murdering another Yemeni at Beidha. The Yemeni authorities had requested that the murderer should be handed over to them for trial, but the Aden Government decided that as he had for many years lived with the Ahl Am Sha'a in the Protectorate, he should be tried by the Audhali Sultan. The political officer who went to Arabah to investigate the matter was unable to persuade the tribe, who are at feud with the Audhali Sultan, to hand over the culprit. It was therefore decided to bring the tribe to submission by occupation of the offending villages by the Sultan's tribal forces, supported by air action if necessary, these forces to remain in occupation until certain hostages were surrendered as a guarantee of the section's future good behaviour. The Sultan was most anxious for this action to be taken, in view of the good effect which firm action of this kind was likely to have amongst the Ahl Am Sha'a.

A time limit was therefore imposed, but as no surrender had been made by the date it expired (January 28), the usual bombing warning was dropped, expiring at dawn on February 14. Action, in conjunction with the Sultan's forces, was taken by aircraft of the Aden Command on that date, one raid being sufficient to bring about the submission of the offending tribe.

Disturbances in Palestine during the past three or four months continued to engage the attention of the security forces, and although the rebels continued their hostile activities the initiative passed from their hands as a result of the continuous pressure exerted against them by air and ground forces.

In Waziristan the prevalence of severe winter conditions resulted in the usual diminution of hostile activity, and the month of December was relatively quiet. The Fakir of Ipi, however, continued his activities against the Government, and showed no signs of willingness to avail himself of the offer of a free pardon contained in the Government's peace terms announced in October. It was decided, therefore, during December to resume the policy of harassing him whenever his whereabouts was discovered, and air action has again been taken against any tribes or villages known to have harboured him. The areas subjected to air action during December were: The Gorwekht, Margha, Mastoi and Splitoi Valleys, and the Shawal Tangi area, including the winter grazing grounds of the Tori Khel Wazirs. The aim of these air operations was successfully achieved in each case, the Fakir of Ipi being kept frequently on the move, and it was hoped that punishment of his harbourers would make other tribes more chary of helping him.

During these operations a Hart of No. 11 (B.) Squadron was fired at from near Chaprai; the air gunner was wounded in the leg. This is the first time during the past two years of operations in Waziristan that any member of the crew of an aircraft has been wounded by hostile rifle fire. Operational flying times during this period totalled approximately 27,000 hours.

A CHEERING SIGHT : A good deal of the obsolescent armament equipment of the R.A.F. is being replaced. This "still" from the A.R.P. film *The Warning* shows the installation of an optical sight on a Lewis gun.

SERVICE AVIATION (CONTINUED)

Royal Air Force Gazette

Air Ministry, April 25

Royal Air Force

General Duties Branch

Flt. Lt. C. R. Taylor is granted a permanent commission in that rank (April 21); D. C. Carleton (from Reserve) is granted a short-service commission as Pilot Officer on probation (April 12); Acting Pilot Officer on probation J. Swyers is confirmed in his appointment and graded as Pilot Officer (March 4).

The following Acting Pilot Officers on probation are confirmed in their appointments and graded as Pilot Officers on the dates stated:—R. H. C. Burwell (March 4); R. W. A. Turtle (April 4).

The following Flying Officers are promoted to the rank of Flight Lieutenant on the dates stated:—G. I. Pawson (January 16); D. P. D. G. Kelly (Acting Flight Lieutenant), J. H. Slater (Acting Flight Lieutenant) (January 27); G. E. Harrison (Acting Flight Lieutenant) (March 14); R. N. Smith, J. P. Marriott (Acting Flight Lieutenant) (April 14); J. R. Gordon-Finlayson, K. A. Merritt (Acting Flight Lieutenant), J. D. Ronald (Acting Flight Lieutenant), D. G. Simmons (seniority January 19) (April 19); P. Stevens (Acting Flight Lieutenant), J. R. Maling (Acting Flight Lieutenant) (April 19).

The following Pilot Officers are promoted to the rank of Flying Officer on the dates stated:—R. F. H. Clerke (seniority January 25, 1938) (April 25, 1938); W. A. Toyne (December 29, 1938); D. A. Robertson (January 29); G. R. Magill (February 28); L. H. Hunt (March 15); A. R. H. Beauman (March 24); D. P. Marvin, R. E. G. Van der Kiste, J. F. Ross, A. D. Watson (March 31); F. N. Hughes, K. H. V. Day (April 3); D. D. Middleton (April 6); J. M. Warren, J. F. Armstrong (April 10); W. T. Russell (April 12).

The following Pilot Officers are granted the acting rank of Flight Lieutenant on the dates stated:—W. C. G. Cogman (March 2); E. P. Henley (April 11).

The following Flying Officers are granted the acting rank of Flight Lieutenant on the dates stated:—K. B. F. Smith, L. Vincent, F. Holman, A. A. Case, P. G. S. Dickenson, K. E. Kennedy, E. P. W. Hutton, M. Nolan, J. B. Tait, R. K. Wildey, J. MacL. H. Sinclair, G. D. Jones, R. D. B. MacFadden, D. L. Amlot, D.F.C., N. M. Boffee, R. S. Allen, J. H. Irvin, R. S. Cannell, A. H. Smythe, H. E. Bufton, G. S. ff. Powell-Shedden, M. C. Pearson, A. A. N. Breckon, J. F. Roulston, G. O. Mills, A. G. Duguid, C. L. F. Colmore, J. S. Kendrick, J. A. Crockett, P. F. R. Vaillant, D. C. F. Good, H. J. A. Thewles, D. H. Cross, T. C. Weir, R. J. Cosgrove, E. C. Cathels, H. P. Pleasance, A. M. McKenzie, D. T. St. H. Dawes, R. P. Wallace-Tarry, P. P. Troughton-Smith, C. A. Vernieux (March 2); G. F. Rodney, A.F.C. (March 6); R. V. Evers-Swindell (March 20); K. N. M. Eyres, J. N. W. Farmer, V. E. Marshall, T. E. J. Fitton, H. A. Hornblow (March 29); G. P. Flew (March 31).

The following Flying Officers relinquish the acting rank of Flight Lieutenant on the dates stated:—W. A. L. Locker, H. Stringer (March 27); P. H. Bragg (April 3); E. J. Little (April 10).

The following Pilot Officers relinquish the acting rank of Flight Lieutenant on the dates stated:—D. M. Taylor (March 10); D. F. Beardon, A. F. McGhie (March 27); P. H. Lee (March 28).

The notification in the *Gazette* of February 28 concerning F/O. J. H. Slater is cancelled; the notification in the *Gazette* of April 14 concerning F/O. A. C. Leggate is cancelled; F/O. A. J. Madge relinquishes the acting rank of Flight Lieutenant (March 6) (substituted for notification in the *Gazette* of April 4); the notification in the *Gazette* of March 28 concerning P/O. A. J. H. Finch is cancelled; P/O. J. P. G. Dunne takes rank and precedence as if his appointment as Pilot Officer bore date March 24, reduction to take effect from March 24; F/O. R. N. Keeble relinquishes his short-service commission on account of ill-health (April 23).

The short-service commissions of the following Acting Pilot Officers on probation are terminated on cessation of duty on the dates stated:—R. L. A. Hammill (November 14, 1938); R. S. Steward, P. J. M. Stone (April 19); G. A. A. Wilks (April 20); A. C. P. MacRae (April 24).

Equipment Branch

E. L. Macro is granted a permanent commission as Pilot Officer on probation (April 3); F/O. R. A. Howes, M.B.E., is promoted to the rank of Flight Lieutenant (April 20).

Accountant Branch

W/O. J. W. Hartzig is granted a commission as Flying Officer on probation with effect from April 10 and with seniority of March 27.

The following are granted short-service commissions as Acting Pilot Officers on probation (April 17):—T. Alderson, S. P. Austin, J. B. Bennett, R. J. Bray, J. A. Bryden, W. A. Covill, J. R. Cox, F. E. Crosland, R. H. Harris, F. D. Holmes, R. R. Jack, A. Lees, D. H. Mortimore, R. Pilsbury, J. A. T. Plummer, P. Raby, J. H. C. Russell, R. J. Sharples, S. C. Tapley, R. B. Thomas, W. B. H. Vidgeon, R. D. White.

Medical Branch

The following are granted short-service commissions as Flying Officers for three years on the active list with effect from April 3 and with seniority of the dates stated:—D. W. Browne, M.R.C.S., L.R.C.P.; D. A. H. Robson, M.B., Ch.B.; G. K. Taylor, M.R.C.S., L.R.C.P.; G. M. Ward, M.R.C.S., L.R.C.P. (April 3, 1938); F. E. Bamford, L.R.C.P. and S. (May 3, 1938); D. A. Duthie, M.B., Ch.B.; D. C. Light, M.R.C.S., L.R.C.P.; H. S. Lillie, M.R.C.S., L.R.C.P.; J. S. Richardson, M.B., Ch.B. (April 3).

W. N. Whiteside, M.B., B.Ch., is granted a short-service commission as Flying Officer for three years on the active list with effect from April 11 and with seniority of April 11, 1938.

Dental Branch

R. A. Abbey, L.D.S., is granted a non-permanent commission as Flying Officer for three years on the active list with effect from April 3 and with seniority of November 2, 1938.

Chaplains Branch

The Rev. P. F. Bailey is granted a short-service commission with the relative rank of Squadron Leader (April 6).

Commissioned Engineer Officer

Flying Officer on probation L. H. Rose is confirmed in his appointment (April 20); F/O. F. G. Hammond is promoted to the rank of Flight Lieutenant (April 20).

LORD RECTOR: Air Vice-Marshal Sir David Munro, who was recently installed as Lord Rector at St. Andrew's University, stepping from an Anson at Leuchars on his way to St. Andrews.

MOSCOW-MISCOU

LAST Friday evening Vladimir Kokkinaki was forced down with engine trouble on the island of Miscou, which lies off the coast of New Brunswick, Canada. Thus ended a meritorious Russian attempt at flying from Moscow non-stop to New York on a Great Circle course. He had left early that morning and had covered a distance of approximately 4,100 miles at an average speed of close on 230 m.p.h.

Kokkinaki was flying the same twin-engined low-wing all-metal monoplane that he had used on his non-stop Moscow-Far East flight last June. It was then fitted with two 800-900 b.h.p. Gnome Rhone engines built under licence in the Soviet. He was accompanied by a radio operator, Gordienko.

The flight started from Schelkovo military aerodrome, near Moscow, where a take-off ramp had been prepared at the end of a concrete runway. The course took the machine over the Island of Hitra, near Trondhjem, Norway, and Budardalur, Iceland. At 4.30 p.m. the crew radioed that they were approaching Greenland, and at 7.26 p.m. a message was received that they had sighted the coast of Labrador. Over an hour later they had passed the Gulf of St. Lawrence.

Unsatisfactory weather conditions had forced them up to over 25,000ft. Shortly after, engine trouble was experienced, and they were forced to return to the Gulf of St. Lawrence. The landing on Miscou island resulted in some damage.

COMMERCIAL AVIATION

PHANTASMAGORIA : A Mid-Continent Airlines Lockheed Electra is run up preparatory to a night flight from the Company's base at Kansas City.

THE WEEK AT CROYDON

Tarmac Control : A Bird Gets the Bird : Preparations for the September Crisis : "A. Viator's" Transport Commentary

SOME confusion seems to have arisen over an innocent remark of mine last week to the effect that sooner or later the Croydon airport authorities would have to take over the tarmac control of the aircraft.

That is not to say that the present system does not work admirably—for it does, thanks to that fine international co-operation which exists at big airports, even though it may be rare elsewhere in the world. But why has it been necessary for the various traffic controllers or supervisors of the companies to form a committee amongst themselves to regulate this matter? Simply and solely because the whole business got into a state of chaos some years ago and the authorities showed no particular capacity for grappling with the problem. Thanks to the co-operation I have mentioned, everything runs smoothly, but there is no doubt that here, as at other big international airports, ground traffic control is essentially the job of some *neutral* authority.

Those who look after it at present have no power to deal, for example, with a recalcitrant aeroplane—say a freighter—which draws up sideways, thus occupying the best part of two berths, and which is unloaded at leisure and afterwards left lying about until the mechanic in charge has had his "levenses." Nor when he arrives, flavoured with ale and onions, and taxies violently away just as the passengers from the air liners are passing behind his tail, is it particularly useful to reason with him for he "don't know nothing about no international co-operation," but anyway no airline bloke ain't got no right to order *him* about."

It comes to this then. The airline people prefer, when possible, to take over a job of this sort, even though the authorities ought to do it and that is their quiet comment on the efficiency of the Air Ministry. I trust the matter is now clear.

Incidentally, looking from my window any morning around 0845 to 0900 hours I see a tarmac crowded with departing machines, which make their dignified and precise get-away one after another. Apart from "droving" difficulties—that is, pushing five or six separate herds of passengers belonging to different air companies of different nationalities and booked for different destinations through passport formalities at the same time and seeing them on to their correct machines—there is another factor people forget about these days, and that is the astonishingly and universally high standard of aero-motor efficiency. Looking from my same window ten years ago, I should have seen at least one departing machine, an Argosy, a Fokker, or a Golden Ray, with ladders all round it and plugs being changed—if nothing worse. There was a whole technique in those days of placating delayed and doubting passengers, whilst worried chief engineers danced around scratching their heads on account of what you might call "a technical 'itch."

If that sort of thing happened more than once in a blue moon these days, traffic would be in a state of chaos. It is well to count one's blessings sometimes.

Ensign Hopes

Eddystone, one of the "E" class air liners which have been moribund for some time, is now said to be undergoing interesting Air Ministry tests with boosted Tigers and constant-speed airscrews. The tests are said to have been satisfactory up to date, but they are being watched with a super-eagle eye by the Imperial Airways pilots, who do not propose, this time, to be satisfied with anything but the very best.

Jacko, the parrot, had a pretty rough ride, not actually (for he came by K.L.M. from Vienna), but metaphorically, when he arrived and found himself classed as an undesirable alien not allowed to stay in this country. Jacko, amongst other accomplishments could say, "How do you do and pleased to meet you" in English and duly said his piece to the authorities at Croydon when he landed.

Later, when told he could not stay, he is said to have remarked, "I don't care a hoot how you do and I wish to take back 'pleased to meet you.'"

All parrots are suspected by the Ministry of Agriculture and Fisheries of having psittacosis, or parrot disease, and are given no chance, apparently, of proving a clean bill of health. The Ministry was adamant and the owners of the bird were greatly distressed. After all, one may be exceedingly fond of a parrot. Why not? Are there not other strange affections, and do not certain folk even love the Minister of Fisheries? Nothing is impossible.

Jacko has had to go back to Vienna, and a fine flow of German, equal in raucous tone and vindictiveness to the very best models, he let fly when he heard it. They say he can telephone, and, if so, all I can say is that it ought to have been arranged for him to ring up Agriculture and Fisheries.

You'd think there would be a spot of human commonsense somewhere in a case of this sort, and that some official would simply say, "Righto, six months" (or six years, for what's that in the life of a parrot anyway?) "quarantine and the bird can stay here."

An amusing incident is said to have occurred in connection with Jacko. One gentleman was showing him to another when the first, by a feat of ventriloquial sleight of larynx, caused the bird to seem to say, "Drunk again, George!" to the second gentleman, who thereupon opined that we did not want such knowing fowl in this country and that it was a good thing he was going back to Vienna.

There is tremendous activity at Croydon at present, doing things in preparation for last September's crisis. The shrubbery, in which I always hoped to take cover in case of war, has been felled and a car park will replace it, while all sorts of underground car parks and other wonders are being prepared.

Anyone who has passed a winter in the terminal block, macintoshed and with umbrella up, will query the capabilities of those concerned to build an underground chamber which will remain dry. Works and Bricks are said to have alternative notice boards to put over the entrance to the new dungeon. One says, "New Car Park, 6d." whereas the other remarks, "Covered Swimming Pool, 6d."

One visualises the opening ceremony of the new venture on a day of brisk spring showers, when the surprised exalted personage (who thought it was a tennis court, anyway) is confronted with a vast underground lake, and, turning to his staff remarks, "Lumme, lads, it's a Lido."

For very many years—more years than he and I care to count—Joe Chamberlain, of Surrey Flying Services, has had a sort of extra birthday on Cup Final day. I met him on Saturday surrounded by a vast and apparently mesmerised crowd of gents in cloth caps and enormous rosettes. It was comparatively early in the morning, but Joe had already had about 100 of his clients up for a flight and was leading another throng towards the joy-ride park.

It is interesting to note that the quite numerous Imperial Airways services to Paris are all doing pretty well, no machine having travelled for some time with less than double figures aboard in the way of passengers. Peak days outwards to Paris are Fridays and inwards Tuesdays. The 1045 hours and 1245 hours services out from England to France seem the most popular and do better even than the old 1230 hours Silver Wing service. The Frobisher class is doing yeoman service and has done much to alleviate disappointment over the Ensign class.

A. VIATOR.

Emergency Route Survey

DURING this summer, probably in June, the Australian Government will be organising a special survey flight across the Indian Ocean between Australia and Africa. For the purpose a special long-range Consolidated PB2Y boat, similar to that to be used by Export Air Lines on the Atlantic surveys, has been chartered from a Dr. Richard Archbold, an American professor of natural history who has been using the machine for survey work in New Guinea.

According to one report the route will be from Onslow, in north-west Australia, to Cocos Island, Diego Garcia Island (in the Chagos group) Port Victoria on Mahé Island (in the Seychelles), and Mombasa—the total distance across the Indian Ocean being nearly 4,700 miles. Another report suggests that Ceylon will be touched at, the machine being put down on Bolgoda Lake, near Ratmalana airport, which is already being considered as a possible flying boat base. Incidentally, another aerodrome in Ceylon, at Puttalam, is ready for use and should have been officially opened at the end of last month. The pilot in charge of the Ocean survey flight will be Capt. P. G. Taylor

The "G" Class

THE first of the Short "G" class boats, *Grenadier*, should be starting its flight trials before the end of this month, and its successors, *Golden Hind and Grenville*, are expected to be out during June.

The boats are being planned for use in three categories, and each has a maximum tankage sufficient for non-stop flights of 3,200 miles. In all probability *Grenadier* will be arranged for the carriage of mails only; but a second version has provision for six passengers in addition to mails and freight; and a third provision for twenty-four passengers. Over a non-stop distance of 1,000 miles or less the "G" class boat will be able to carry a payload of something like twelve tons—which is equivalent to some 120 passengers and their luggage.

The work on *Grenadier* is almost completed; the wings and tailplane have been attached to the hull and the engine installation arranged. Great care has been taken to make the machine as clean as is possible in the case of a flying boat. Flush riveting is used, and where the skin plates overlap one is indented so that the joint is perfectly smooth. Needless to say, such items as mooring bollards are retractable. The engines will be the new Bristol Hercules fourteen-cylinder sleeve-valve units, and the four of them will, together, give more than 5,500 h.p. for the take-off. The engine mountings are independent of the main structure so that each entire installation can be removed bodily—or, of course, the engine separately from its accessories.

Incidentally, Imperial Airways last week took delivery of two of the three strengthened "C" class boats which are destined for the Tasman Sea service. They were flown from Rochester to Hythe by Captains D. C. T. Bennett and J. W. Burgess. These two particular boats are named *Australia* and *Aotearoa*; the third boat, which should be launched this week or early next, is named *Awarua*.

Until the necessary organisation at Sydney and in New Zealand is complete, these three boats will probably be used on the normal Empire routes. They can, it will be remembered, take off at an all-up weight of 46,000lb., and are stressed to 53,000lb.—though this is only of refuelling interest in the case of the Atlantic version.

It now appears that the high-altitude type of the Short landplane is expected to have a maximum speed of more than 330 m.p.h. when flying at heights in the region of 25,000 ft. In last week's issue we gave the cruising speed for this version as 275 m.p.h. and the maximum range as being well over 3,000 miles. The medium-altitude type, two of which have been ordered, will carry from fourteen to eighteen passengers and will have a maximum speed of approximately 280 m.p.h. at 5,000ft.

Guernsey Details

THE new Guernsey airport at La Villiaze will, as already stated, be officially opened to-morrow by Sir Kingsley Wood, the Secretary of State for Air. The control-manager will be Flt. Lt. F. A. Swoffer, who was, until recently, in charge of control at Southampton Water. He will have a staff of sixteen.

The airport offices comprise the usual control rooms, wireless, Customs and restaurant. As a comparison with other recently opened and operating airports, Guernsey's grass landing area will cover ninety-seven acres. The landing lights have already been installed by Chance Brothers, with other lighting by the G.E.C. Marconi's have supplied the D/F wireless equipment.

The African Accident

WHEN arriving at Mozambique last Monday the Imperial boat *Challenger* was wrecked on the shore. At the time of going to press the cause of the accident is not certain, but the machine appears to have struck a small boat, swerved and run inshore. The flight clerk, Mr. G. Knight, was reported to be killed, and the radio operator, Mr. T. Webb, missing. No one else was seriously hurt; there were three passengers and three other members of the crew.

COVENTRY A.I.D. CELEBRATES

THREE years ago the A.I.D. folk at Coventry decided to organise a dinner of their own. Nearly one hundred attended. Last Thursday evening, at the third and best dinner of the series, this number was quadrupled.

The dinner was held at the Rialto Casino, Coventry, with Mr. S. J. Norton in the chair.

After the Loyal Toast, the task of proposing the toast of "The A.I.D." was entrusted to Mr. C. S. Oliver (Hawker-Siddeley Group) and Mr. W. W. Vinsen (British Thomson-Houston, Ltd.). For the majority of the company the former's words were difficult to hear, for the amplifying apparatus decided to go on strike at the critical moment. He said that the increased size of the party was due to national expansion. He recognised that the A.I.D. was responsible for the high standard of aircraft efficiency which was being maintained to-day. The co-operation between Inspection on the one hand, and Production on the other, was excellent—everybody was out to help in a time of national need.

In seconding this toast Mr. Vinsen asked, meaningly, why it was necessary for two people to propose it, while there was only one to respond. He welcomed the opportunity to pay a tribute to the work of "this unique organisation," and also to the manner in which it was surmounting the difficulties of the Government's rearmament programme. Not the least of its problems was the need of recruitment and training made necessary by the demands of increased inspection. In conclusion, he said that the A.I.D. had been called upon to bear an immense amount of responsibility. He was certain that it would respond manfully to the many calls made upon it.

Group Capt. Sowrey, A.F.C. (Director of Aeronautical Inspection) then replied. In the first place, he said, he was glad to be in Coventry again. Judging by the strength of the A.I.D. in this district it was possible to realise the growth in industry there. He pointed out that the efficiency of the scheme depended on co-operation of the approved inspectors and the A.I.D. He spoke of Colonel Outram who, although now Director of Aeronautical Production, still had his heart with the A.I.D. In closing, he stressed the fact that the difficulty in keeping pace with the enormous expansion was being successfully met by the firms as well as by the A.I.D.

The next and last toast, "The Visitors," was proposed by Mr. S. J. Norton, who answered Mr. Vinsen's query about having two proposers to one toast by saying that if the first speaker had nothing nice to say about the A.I.D., the chances were that the second had. In greeting the guests he mentioned that the whole-hearted response to the invitations to the dinner was indicative of the excellent spirit everywhere.

In the absence of Capt. W. F. Strickland, M.P., Mr. H. H. Bacon took his place at short notice. Capt Strickland, he said, had been called by the Government Whips only four hours previously. It was peculiar, he thought, that the Captain had been kept away that evening by the "three-line" Whip of a Government whose Home Secretary had decided to abolish flogging.

Seconding the reply to the last toast, Mr. H. H. Harley (Coventry Gauge and Tool Co., Ltd.) protested that he did not know what the real object of the dinner was, but if all those in the room were members of the A.I.D. he was convinced that the visitors were in for a warm time.

The evening drew to a close at midnight, after a first-class cabaret show—which, incidentally, tended to recall a certain episode in the City of Coventry's history.

CORRESPONDENCE

(*Continued from page* 450.)

problems will be too considerable for this year's Atlantic service to be run to schedule."

I might mention that flying an aeroplane is a difficult process and also landing one and taking it off; they all require considerable skill.

I would also like to mention that the whole art of flight refuelling depends upon the pilot and crew of the tanker, not the receiving aircraft.

I have often said that five minutes' conversation is sufficient instruction for the pilot of the airliner who is about to be refuelled. He has just to carry on his course and fly his machine in a steady manner. I will guarantee that we will refuel him and he will not know whether the operation has been carried out or not, so slight is the interference of the connection made with the hose to the rear of the aircraft.

Flight refuelling has suffered in its development stages because it is so simple, so adaptable, and so mobile that the research has had to be carried out with modified aircraft, and I suppose it will continue for a long time to have its development carried out with modified aircraft. Everybody is aware of the difficulty of modifications. But when the very simple requirements of flight refuelling are called for in the original design of either receiver or tanker, 90 per cent. of the difficulties of the present day will disappear.

Forgive me for making one last quotation from your remarks. You say "that the operational problems will be too considerable for this year's Atlantic services to be run to schedule."

I take exception to this remark, if it is implied that the flight refuelling operational problems will be too considerable. I consider that until the service has been run such a forecast should not be made.

What I would like to see is that we are given a chance to prove our convictions, and, as I have said before, we are ready to refuel the Atlantic service according to schedule. The tankers have arrived at Montreal. Shortly they will be erected and flown to Newfoundland. That big problem has so far been conquered. The Shannon Airport is in grand trim, and our tankers will be ready to fly as soon as they are wanted.

I am happy to tell you that I am receiving the whole-hearted collaboration of Imperial Airways in the training of their staff for their part of the refuelling operation.

If the Atlantic service does not start the reason will have nothing to do with flight refuelling.

ALAN J. COBHAM,
Flight Refuelling, Ltd., Managing Director.

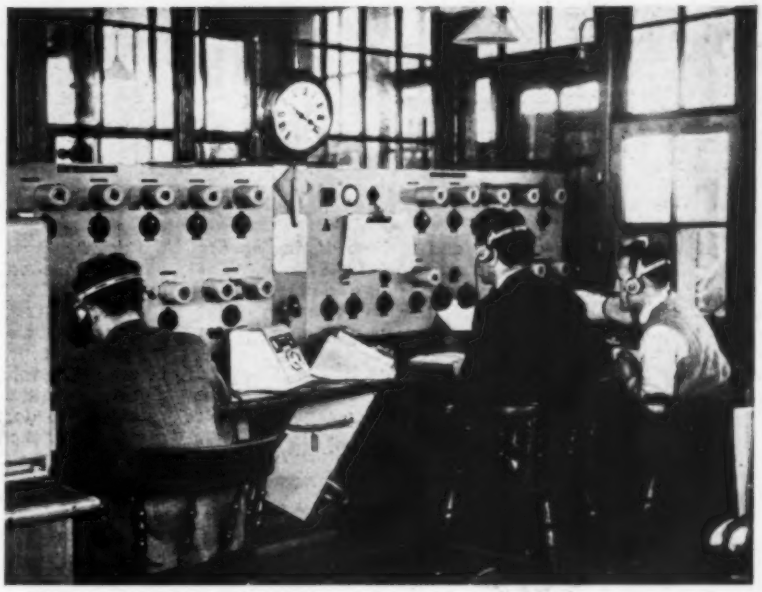
RECORD PROMOTION: Herr Fritz Wendel, who has been promoted by Field Marshal Goering to the rank of Flight Captain following his attainment of about 470 m.p.h. in a Messerschmitt Me. 109 R monoplane fitted with a Mercedes-Benz engine. Judging from the photograph the machine—which apparently beats the Heinkel's three-week's-old record—has clipped wings, a hidden radiator, a revised cockpit enclosure and additional fin area below the fuselage.

TOWARDS 100 per Cent. REGULARITY

Part II: The Technique of Blind Approach and Landing

By FRANK BRENT

This article — the first part of which appeared last week —is by a commercial pilot with unusually extensive experience of flying in bad visibility. For a considerable time he has been working Wrightways' "dawn" freight services.



THOSE WHO ARE IMPORTANT BUT FORGOTTEN: Operators at work at two of Croydon's three D/F receivers. It would be pleasant to say that they are busy giving QDMs, but in fact the controlled zone D/F receiver is not in the picture. Presumably Croydon will eventually have a separate gonio hut for "ZZ" work. As it is, the pilots "home" on the control tower.

THERE are three methods in use by which a blind approach can be made; namely, by a series of bearings and a descent to below the cloud ceiling when near or over the aerodrome, by the "ZZ" method and its variations, and by the aid of an approach beacon.

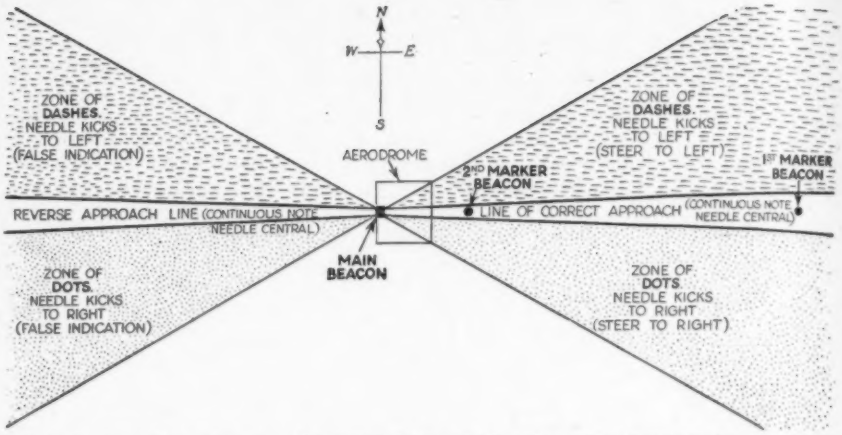
The first method can only be recommended with a ceiling of at least 100 metres above the highest obstruction in the vicinity of the aerodrome, for there is a lack of definiteness about the information which can be given to a pilot as to his position over the aerodrome. The only method practicable for this is for an observer on the ground to send signals saying where the noise of the aircraft's motors can be heard, and such signals are by their nature very approximate and convey no information about distance.

If this method has, unfortunately, to be adopted, the following procedure would appear to be more suitable than a random descent somewhere near the aerodrome on "motor signals." It can be used with ceilings much below the height of local obstructions if the approach is made on the best approach line and the pilot is absolutely familiar with the topography of the place. On receipt of Turn No. 1 a bearing and distance from the aerodrome are obtained so that the time and arrival over the aerodrome will be known in advance. Approach is made on a series of magnetic reciprocal bearings whilst descending to a height which will give a clearance of at least 150 metres over any local obstruction or high ground. The direction of the preliminary approach is best arranged so that it will lead across the aerodrome towards the lowest and most obstruction-free area, but if this cannot be done without making a special detour it is not really worth while, as it must be remembered that time is an important factor, and there are probably other machines waiting to land. On receipt of the signal "QFG," or "Motors Over," the aircraft is turned on to a heading of about 30 degrees from the reciprocal of the track on which it is intended to make the final approach, and height is reduced to the minimum which is safe in that area. The undercarriage is lowered, the airscrew pitch reduced and as much flap applied as can be used without adversely affecting the subsequent take-off and climb should the approach have to be abandoned. The series of QDMs is continued (there is no point in changing to QDRs as sometimes advised—it only leads to confusion), and after, say, two minutes a turn at a rate of about 180 degrees a minute is made until the bearing of the desired approach line is picked up.

Frequent bearings are naturally essential, and much depends on the skill of the radio operator, who should be able to get at least three reliable bearings a minute, although two good bearings are infinitely better than three or more doubtful ones. Descent is made to the minimum safe height on the approach line selected and speed reduced to the minimum for handling the aircraft with full control. If the ground becomes visible, even if only vertically beneath, before or when the minimum safe height is reached, the approach will probably be successful provided that correct bearing is maintained, but if the ground is not seen from that minimum height within 1½ minutes after completing the 210-degree turn made in picking up the approach bearing, any attempt to continue the approach is dangerous, and the aircraft should be put into its maximum climb on the best "escape line" (which may or may not be straight ahead) until an obstruction-free height is reached.

With two pilots it is best for the co-pilot to fly the machine up to the point when the aerodrome is crossed on the preliminary approach so that the commander is free to check up all the many things which must be attended to. A solo pilot must be absolutely sure of himself and adhere to a prearranged plan to avoid having to work out anything new.

The tricky part with very low ceilings is when actual sight of the ground has to be looked for, it being rather difficult both to fly the aircraft in a necessarily very precise manner as regards course and height (the latter being


N
W
E
S
ZONE OF DASHES. NEEDLE KICKS TO LEFT (FALSE INDICATION)
AERODROME
2ND MARKER BEACON
1ST MARKER BEACON
ZONE OF DASHES. NEEDLE KICKS TO LEFT (STEER TO LEFT)
REVERSE APPROACH LINE (CONTINUOUS NOTE NEEDLE CENTRAL)
LINE OF CORRECT APPROACH (CONTINUOUS NOTE NEEDLE CENTRAL)
MAIN BEACON
ZONE OF DOTS. NEEDLE KICKS TO RIGHT (FALSE INDICATION)
ZONE OF DOTS. NEEDLE KICKS TO RIGHT (STEER TO RIGHT)

A simplified and purely diagrammatic representation of a typical ultra-high-frequency approach beacon layout. Needless to say, the continuous note and "E" and "T" zones are not by any means as clearly defined as the diagram indicates. As a matter of interest, the appropriate movements of the Lorenz type of indicator needle is also given for the four sectors, but in practice the pilot is concerned only with the aural signals, since his eyes are busy first with the essential flying instruments and, later, on the look-out for the first appearance of the ground.

obviously extremely critical) and to keep casting an eye over the side trying to pick up something definite. The only advance warning that is obtained is a kind of darkening underneath which indicates that the ceiling is about to be broken, but if this should become visible only when the minimum safe height has been reached and clear sight of the ground is not obtained at that height, the pilot must not be tempted to come down "just a little bit lower" in the hope of seeing more, but should abandon the approach. It cannot be too strongly emphasised, however, that this admittedly crude method of blind approach cannot be recommended, and, as the equipment needed to obviate its use except in emergency is now available, there is no justification for its continued use.

The "ZZ" system, so called because the final signal to land sent to the aircraft is "ZXZ," X being the last letter of the call sign of the ground station, employs a D/F installation-cum-listening post situated some 400 metres outside the aerodrome boundary on the approach line, the bearing of which is specified. If it appears that the aircraft, which approaches on a series of QDMs, passes over the listening post in such a way that a landing is possible, the observer there sends the signal ZXZ or YXY, according to whether he is a representative of the company owning the machine or of the airport authority. If a landing appears impossible the signal JXJ is sent. In some cases the "ZZ" signal is not used, but signals of "MW," "MNE" (meaning that motors are audible at the compass point indicated) are sent, and in practice this appears to work just as well within the limits of the system. The main disadvantage of the basic scheme is that no warning can be given to the approaching aircraft that it is near the aerodrome until its engines are heard, and if at this instant the aircraft radio operator has just pressed his key to "run for a bearing" there will be a time lag of perhaps 20 seconds before the "motor signal" is received by the pilot, and this time may be sufficient for the aircraft to travel so far across the landing area that a direct landing cannot be made from the height at which the machine will be. At certain Continental aerodromes this difficulty is met by the provision of an additional listening post some few kilometres from the boundary on the approach line and in telephonic communication with the D/F station, and at Heston a "ZZ" system has been operated in conjunction with the marker beacons of an approach beacon installation. Experiment is also being made, again on the Continent, with a D/F post located to one side of the approach line in such a way that good cuts can be obtained all the way down the line from about 20 km. distance. The goniometer at this post is of an automatic type capable of giving remote indications at the aerodrome D/F station, where the milliammeter (which is the actual indicator of the bearing of the received signal) is fitted with a long pointer and is mounted on a large-scale map of the approach sector with the pointer spindle on the map position of the D/F post. In conjunction with plotted lines, both of bearing and of distance from the aerodrome D/F station, the position of an approaching machine can thus be seen by inspection every time it runs its transmitter, so that bearings and distances can be sent without the usual delay which arises when bearings from an independent collaborating D/F station have to be plotted by hand

Where there is only one listening post the approach proper is best started from a position over the aerodrome, for as a descent to a very low altitude has to be made before the listening post is reached, the pilot must know his distance from the aerodrome to within close limits, and the only way to do this is to work on a time basis from a passage over the aerodrome itself. At some airports it is possible to get a series of "QGEs" (bearings and distances taken simultaneously), but even the short time lag while the necessary plotting is effected is enough to make the use of these QGEs impracticable in most cases as a basis for descent during a direct approach, for on almost all approach lines there are obstructions to be considered and a premature descent to the very low height at which one must pass over the listening post is fraught with danger.

Last-minute Procedure

A general procedure, similar to that suggested for the first approach system described in this article, will be found quite satisfactory, but when the final "motor signal" is received, be it "ZZ," "YY," or "M" and a compass point, and provided the last bearing received was correct, descent can be made from the minimum approach line safe height to below the ceiling with the knowledge that the aerodrome is just ahead. If, by reason of the time lag referred to above, this descent results in breaking through too far across the landing area, it will be necessary to go round again, and the pilot must know by previous experiment in fine weather just how far it is possible to continue an overshot landing with any particular machine. Any tail wind, however light, is most misleading in these cases. It is rarely possible when approaching on a series of bearings to pick up and hold the exact approach line heading, so it is advisable to steady-up on the first bearing received, which is within, say, five degrees of the actual heading. Any attempt at greater precision is almost certain to result in "hunting" and a spoilt approach, and if the approach becomes erratic for this or any other reason it is most inadvisable to try to straighten it up by large alterations of course when very close to the aerodrome—much better repeat the whole procedure and eliminate the risk of arriving at the boundary in the wrong direction, perhaps heading towards obstructions. With an additional listening post the decision as to whether it is advisable to commence the approach with a passage over the aerodrome will depend on the nature of the surrounding country, for if it is possible to fly freely in the locality of a height from which a not too rapid descent can be made after passing the advance listening post, much time will be saved if the approach is based on a QGE and the minimum safe height for the locality maintained until the advance listening post has been passed. Otherwise, the certainty obtained by starting from over the aerodrome is essential, as, for example, at certain Swiss aerodromes surrounded by mountains. The signal in common use to indicate that the aircraft's motors have been heard at the advance post is "ü ü." Granted practice, complete familiarity with the aerodrome and its

surroundings, and skilful air and ground radio operators in close co-operation, a pilot can effect blind approaches by this system consistently and safely with ceilings down to as low as 50 metres, and in visibilities as short as 400 metres. Variation of these figures is naturally dependent on the many factors involved, and they apply to daylight operation only. Whilst any "ZZ" system will compare unfavourably with an approach beacon, it must be realised that it has the great advantage that it can be operated as long as the aircraft has two-way medium-wave communication equipment functioning. Even were all aircraft equipped with receivers for landing-beacon signals, a "ZZ" system would provide a valuable stand-by for possible cases of inability for any reason to receive those signals.

The development of approach beacons giving an interlocked "E" and "T" signal on the approach line, combined with marker beacons on that line to give indication of distance from the landing ground, has simplified the problem of blind approach enormously, and up to the present this system affords the easiest and safest solution, enabling as it does the making of regular-service landings in visibilities down to 200 metres with ceilings as low as 30 metres, depending always on the suitability of the aerodrome and approaches and the aircraft used. Absolutely blind landings have frequently been made with the aid of these beacons—indeed, they have been made with other less satisfactory systems—but the large element of risk involved places such landings entirely outside the province of regular operation, and the optimistic and misleading statements regarding them so often expressed by pilots with no real experience of fog landing (to say nothing of non-flying authors of books on radio and the like) cannot be too strongly discounted.

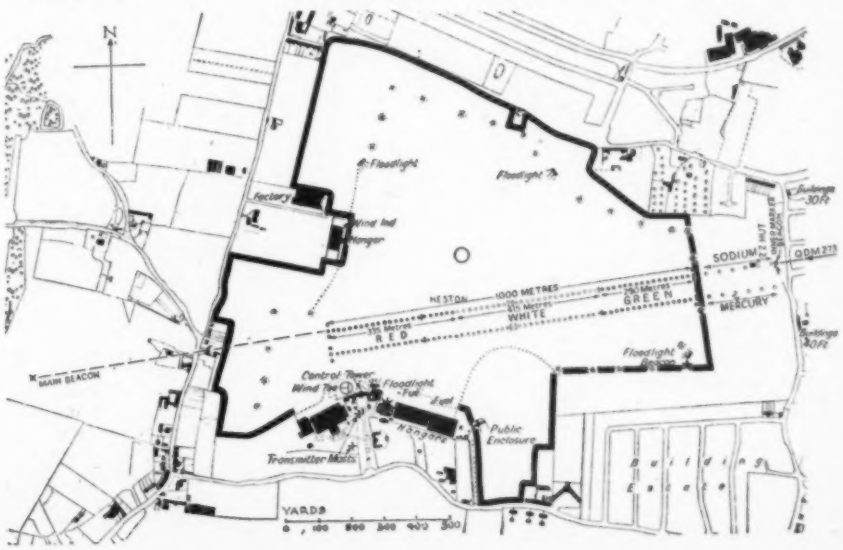
Early attempts at providing continuous horizontal guidance included various interlocking signals on medium and high frequencies, using both keyed emission from crossed loops giving overlapping "figure 8" polar diagrams, and combinations of vertical and loop aerials giving a periodically reversed "cardoid" diagram, as well as adaptations of the leader cable which has been used for marine work. Effort has long been made also to provide some form of vertical radio guidance. This was done with the leader cable by earthing it at intervals through resistances of various values so that a constant field strength was produced along an inclined path. With the medium-frequency beacons a separate high-frequency transmitter emitting a horizontally polarised wave reflected at an angle was tried, and with the various high-frequency beacons use is made both of this scheme and of one in which an aerial system giving on one frequency a pattern of field similar to that of the well-known Lorenz beacon, affording simultaneous horizontal and vertical guidance.

For reasons which are too complex to discuss here, the writer considers that none of these means for providing vertical guidance is satisfactory (the main difficulties are those of maintaining a stable glide path and the virtual impossibility of matching up the actual glide of different aeroplanes with the radio glide-path, be this either straight or curved) and vertical guidance is in practice obtained from a sensitive altimeter. It is by no means improbable that a satisfactory radio glide-path will eventually be developed, and then the altimeter may be used as a check against the glide-path indicator. The horizontal guidance given, however, leaves little to be desired, although with high-frequency beacons there have been and are many cases of unsatisfactory equi-signal tracks, dead areas, etc., due to local effects of hangars, high ground and so on. At the short distances involved these troubles do not appear to arise with medium-frequency beacons, which, however, are at a disadvantage in Europe because of the shortage of frequencies available.

The standard arrangement of approach beacons provides for an equi-signal zone indicating the approach track, the dots and dashes which interlock to form this being disposed to the left and right of it respectively when facing the aerodrome. With most systems the beacon radiates a reciprocal track also, but whilst there are means of eliminating this it does on occasion prove useful, and in most cases is best retained. Distance from the aerodrome is indicated by marker beacons giving a more or less vertical radiation only. The usual arrangement is to place one just outside the aerodrome and one 4 km. away, but as with fast machines this is found to give insufficient advance warning to facilitate the consistently smooth and quickly executed approaches which are essential at any busy airport, it is proposed to add a third marker farther away on the approach line, and this promises to be a great advantage.

Ultra-Short-Wave Technique

The approach procedure with a beacon will seldom be the same at different aerodromes, and will also vary according to the route of the aircraft and whether it is able to land direct or has to wait a turn. If the aircraft is for any reason on the side of the aerodrome remote from the blind-approach sector it is helpful to cross directly over the aerodrome, as this gives an easy basis to work from, and will, of course, verify the reception of the markers, but if the machine is already in the vicinity of the approach sector it is better and quicker to go straight in. The procedure is identical with medium- and high-frequency installations provided that for using the former there is a separate receiver for the pilot so that the watch on the two-way communication frequency need not be broken. If watch has to be broken because only one receiver is provided, there is no real difficulty, but only a necessity for a somewhat more complicated signal routine to obviate the possibility of misunderstanding. It is not generally known that most approach beacons can be switched and keyed by hand



The present layout at Heston airport, showing the arrangement of the recently installed contact and experimental threshold lights. The latter are designed to guide the pilot on the contact strip from the moment when he is crossing the inner marker beacon—or before.

so that ordinary signals can be sent, and by this means the ground station can call the aircraft if necessary when two-way watch is broken; but, naturally, whilst this is being done the normal characteristics of the beacon are in abeyance.

The same considerations as regards minimum safe heights as apply to other approach methods are equally applicable to a beacon approach, and until the advance marker (if any) and the distant marker have been passed the minimum heights appropriate to their respective positions must be observed. When permission to approach on a beacon has been received, a QGE in the usual manner will give a basis from which to start. The aircraft should be flown so that the beacon axis is crossed at a fairly acute angle—say, 20 or 30 degrees—otherwise there will be difficulty in aligning the machine on it in the limited distance and time available.

If the directional gyro has been kept carefully checked against the compass it should not now be further altered in any way. As soon as the equi-signal zone is entered the course is changed to the known bearing of the beacon axis, making an approximate allowance for drift, if any. If drift is present it is of no avail trying to measure or calculate it with any accuracy, for the aeroplane will be descending through a constantly changing wind, and drift correction can only be made according to the guidance given by the beacon. The trickiest case is when a head or tail wind changes direction with height in such a way that the drift becomes reversed during the descent after passing the distant marker, and this, unless it has been anticipated, can give rise to great misgivings as to the functioning of the directional gyros.

Aural Signals Only

If, after allowing for drift, the D.G. readings do not agree with the known beacon axis bearing when the aircraft is kept in the equi-signal zone, it is of no moment provided the apparent error is not more than, say, 10 degrees. The important thing is to stay in the equi-signal zone to the exclusion of all other considerations as far as direction is concerned, and for this much practice is necessary to ensure smoothness. It is better to ignore the beacon receiver visual indicator entirely, for there are quite enough other visual instruments to be watched, and it is manifestly logical to use as many senses as possible so that the minimum number of items are apportioned to each. All the useful information the beacon can give is audible in the earphones, so that the only instruments to be watched are the directional gyro, the artificial horizon, the A.S.I., and the altimeter. The necessary attention to flaps, undercarriage, etc., as for other approach methods is probably best given before the beacon axis is picked up, so that no more adjustment to them will be needed when concentrating on the actual flying of the aircraft in a necessarily precise manner.

By working on time from the basis of the QGE obtained, the speed of the machine should be reduced to the minimum for safe handling by the time the distant marker is reached (this is where the advantage of an advance marker is apparent), then a descent is made immediately to the minimum safe height for the area between this marker and a point some 200 metres past the beacon transmitter on the far side of the landing area—this is to provide for the case of an overshot approach. Efforts at adjusting the glide so as to produce a uniform rate of descent from the distant marker to the boundary marker are seldom successful, and in the writer's opinion not advisable, for such efforts introduce an added complication of a variable factor into an already critical process.

It must be borne in mind that with almost all transport aircraft the speed and height on crossing the boundary must be just right if a landing is to be possible at all, and any excess of either, very likely if an adjusted glide does not work out properly, will probably mean going round again. Once at the minimum height allowable after passing the distant marker the approach should be continued on instruments only, without either looking for the ground or descending farther until the boundary marker is heard, when final descent will bring the ground into view—unless, of course, the ceiling has already been broken. It is a good thing, if only for practice, always to continue any approach on instruments, even if the ceiling is broken before reaching the boundary. For the final picking-up of the ground and the landing the provision of the most extensive contact lighting that can be installed is the ideal to be aimed at. It is a moot point whether contact lighting extending past the boundary marker outside the landing area is justifiable. The writer inclines to think not, for if pilots will rigidly adhere to the minimum safe-height requirements until the boundary marker is reached without trying to look for the ground, there can be no danger of hitting anything, and the final descent below that minimum safe height will take place just outside the boundary where there will be no obstructions—or where there should be none if the aerodrome is properly laid out! In all cases it is vital to realise that if only one of the several factors involved is in error the approach is unsafe, and quickness to perceive such errors is as essential as ability to carry out the actual manœuvres demanded by the approach itself.

Possibility of Failure

Observance of a system as suggested will cover all eventualities, including failure, for any reason, to pick up the markers, which is a very important consideration. If the distant marker is not heard there will be no descent below a safe height for any position in the vicinity, and provided the beacon axis is followed the passing of the cone of silence of the beacon transmitter will indicate that the landing area has been overshot, when, of course, it is obvious that the approach is a failure unless the ground comes clearly into view. If the boundary marker is not heard, the aerodrome will be crossed at a height which, whilst very low, is still sufficient to clear all obstacles that may be encountered before passage over the cone of silence of the beacon transmitter gives warning that the maximum climb consequent on an overshot approach must be begun. Failures in service with beacon approach apparatus are very rare, but there is no reason to neglect the most careful provision for all possible sources of trouble that may arise.

There are many incidental points which in all methods of blind approach are found to need attention, and many minor difficulties which can be overcome only by constant practice. It cannot be too strongly emphasised that if operation in foggy weather is to be pursued to the utmost possible safe limit it is essential that pilots should be given every opportunity and encouragement to carry out the necessary personal experiment and practice at various aerodromes, and that the question of full-scale training in all methods of blind approach and take-off—a matter lamentably ignored in this country, except in a few cases—should be given the consideration it warrants.

THE R.A.F. TO-DAY

AS a prelude to Empire Air Day—to be held on Saturday, May 20—*FLIGHT* will publish its special

ROYAL AIR FORCE NUMBER

on Thursday, May 18.

This greatly enlarged issue will contain articles describing the work and equipment of the R.A.F. and Fleet Air Arm, special pictorial features, and a guide to Empire Air Day displays.

Thursday Week FLIGHT ***May 18***

THE INDUSTRY

"Flight" photograph.

CAPT. BALFOUR, Under-Secretary for Air, sees Hampdens in production. On the right is Mr. Handley Page and on the left Rear-Admiral Sir Murray Sueter. The visit of Capt. Balfour and the Parliamentary Air Committee to Cricklewood and Radlett is reported on page 448.

The Re-rated Tiger IX

THE new version of the Armstrong Siddeley Tiger IX engine installed in the Armstrong Whitworth Ensigns for Imperial Airways is known as Tiger IXCs, and has the following characteristics: International rating, 775/805 h.p. at 2,375 r.p.m. at 6,250ft.; maximum power rating, 810 h.p. at 2,450 r.p.m. at 6,500ft.; maximum take-off power, 900/935 h.p. at 2,375 r.p.m. at sea level. Cruising at sea level under maximum continuous conditions the engine delivers 650 h.p. at 2,150 r.p.m. and consumes 50 gallons of fuel an hour. The airscrew is a constant-speed De Havilland weighing 355 lb.

Dagger III Overhaul Period Extended

AN inspection report on a Napier Dagger III engine after 320 hours' running reflects the excellence of workmanship and soundness of design of this 24-cylinder unit. Two engines of the type have been under observation for 320 hours. They were installed respectively in Hawker Hectors at No. 13 (A.C.) and No. 53 (A.C.) Squadrons, and on being stripped their condition was found to be so satisfactory that the Air Ministry decided to extend the overhaul period to 480 hours.

The logbook of the unit installed in the Hector of No. 13 Squadron showed that during the complete service life of the engine one new magneto, four new distributor heads and one new inlet valve spring had been replaced and one carburettor had been fitted from another engine.

Apart from the routine processes of removal of carbon and general cleaning-up the strip inspection report called for the replacement of the following in addition to the normal "consumable" parts: One main bearing, one cam drive bush, one timing case bevel gear, piston rings (gas and scraper), valve guides, one bush, one exhaust valve, one valve spring (inner), one valve spring (outer), and one cylinder stud. None of these parts was dangerously worn or damaged.

Instruments for All Purposes

BY describing their latest publication as a "general bulletin," Negretti and Zambra hardly do justice to what is in actual fact a detailed illustrated summary of over sixty precision-made instruments for an immense variety of purposes.

This 60-page booklet deals with a number of aircraft instruments, including air temperature thermometers, boost, fuel pressure and oil pressure gauges. There are, of course, many other instruments which are appropriately dealt with. The publication is obtainable from Negretti and Zambra, 38, Holborn Viaduct, London, E.C.1.

Transportable Hangars

ANNOUNCED last week was the formation of Bellman Hangars, Ltd. The company is to market the Bellman transportable hangar—designed by Mr. N. S. Bellman, late of the Air Ministry—which has been adopted by the Government on a large scale.

A group of prominent steel firms is interested in the venture and is already mass-producing the hangars.

Orders, it is stated, have been received from other Governments, and the object of the company is to promote export business.

A certain proportion of the shares is to be held in trust for the British Government.

Inexpensive Timing

A WRISTLET stop-watch at a price of 15s. is one of the latest products of A. Arnold and Co., of 12, Henslea Avenue, Golders Green, London, N.W.11.

Pneumatic Production

A NEW catalogue issued by Broom and Wade, Ltd., of High Wycombe, deals with their pneumatic tools for aircraft production. The items covered include light-duty riveting hammers, long-stroke hammers, portable and stationary squeeze riveters, grinders, nibblers and special column- and cradle-mounted riveting machines. Air hose and fittings are also dealt with.

More Than a Catalogue

MOST catalogues worthy of the name are informative, but the latest issue of the version issued by Smith's Aircraft Instruments, Ltd., easily excels any of those previously published by this company. It is more than informative, for not only is every instrument described in detail, but installation diagrams, maintenance notes, constructional details and technical specifications are also supplied. In fact, towards the end, where various types of sextants and navigational computors are described, the instructional value of the details given is so great that it becomes a veritable manual on air navigation.

This catalogue, which is published from the Cricklewood Works, London, N.W.2, of Smith's Instruments, Ltd., extends to over 120 loose-leaf pages.

For Cutting Intricate Shapes

A NEW bench-type filing and sawing machine has recently been introduced to this country. It has been designed for cutting intricate shapes in steel, brass, bronze and aluminium, such as those usually encountered in die-making.

The machine, which is known as the F.S.1 Kulaso, is fitted with a ¼ b.h.p. motor taking 240 watts. The stroke of the ram is adjustable between 1.379in. and 3.546in. By means of a three-step cone pulley the main drive of the actuating ram can be altered to provide cutting speeds of 150, 210 and 300 strokes per minute, to suit the requirements necessary for sawing and filing various types of material. A 15in. swivelling and tilting table is fitted.

The Kulaso is being handled in this country by the Rex Hacksaw and Tool Mfg. Co., Ltd., First Avenue House, High Holborn, London, W.C.1.

Standard Steels

ENGINE manufacturers in particular will be interested in a new list entitled *Summary of Standard Steels* issued by the English Steel Corporation, Ltd., Vickers Works, Sheffield. Very complete data, including typical uses, are given for some forty different grades of steel.

"Straight Aviation Training"

A NEW subsidiary of the Straight Corporation, recently mentioned in our "New Companies" column, is registered as "Straight Aviation Training, Ltd."

Self-contained

A COMPACT and economical portable electric generator set, known as the "Pygmylyte," is described in a leaflet issued by the manufacturers, Bradby's Engineering Works, Ltd., Norwich House, Southampton Street, London, W.C.1. The set comprises of a 1½ h.p. four-stroke engine driving a generator giving an output of 360 watts at 12 to 15 volts.

Under a New Name

RECENTLY the name of the D.K. Corporation was changed to Aero Plastics, Ltd. Coincident with the renaming of the company there has been an increase in its capital, which has been raised to £25,000. Major C. J. P. Ball, D.S.O., M.C., and Major Stanley Mohr, O.B.E., M.C., M.I.E.E., have joined the Board. The firm specialises in laminated sections suitable for various aircraft parts. Its address is 39-40, Albemarle Street, London, W.C.1.

Guaranteed According to Test

MANUFACTURERS frequently have their products officially tested, but not all of them are prepared to guarantee that their products in service will attain the same high degree of efficiency as that obtained in the test.

However, a well-known firm of drill makers recently had a series of striking tests on their products carried out at the Sheffield Testing Works, and, although the figures obtained were approximately 90 per cent. above B.E.S.A. specifications, this firm is prepared to guarantee that every drill that is sold in the sizes shown on the test sheet will equal the performances given in the tests under the same conditions of feed, speed, etc.

The firm concerned is the Sheffield Twist Drill and Steel Co., Ltd., of Summerfield Street, Sheffield, 11. It specialises in the manufacture of high-speed Dormer twist drills, eight sizes of which were subjected to the tests. The company has also developed drills specially suitable for the aircraft and light metal industries, such as cotter-pin drills for use on laminated aircraft parts, quick spiral drills for use on aluminium, duralumin and other light metals, and, finally, crankshaft drills for deep holes in tough materials.

Testing Wear and Lubrication

ENGINE manufacturers in particular should find useful applications for a new, compact and fundamentally simple "wear and lubricant testing machine" evolved by British Timken, Ltd.

In essentials the machine consists of a revolving test-piece of known characteristics; a load lever to bring a specimen test-piece into any required degree of frictional contact with the revolving piece; and a second lever by which the friction generated can be measured. The speed of revolution can, of course, be regulated.

The effect of lubricants on the test-pieces, or the effectiveness of lubricants as such, can be determined by the same means, a circulating system being provided whereby oil can be fed at a predetermined rate and at any required temperature. Greases may also be tested.

The utility of the apparatus for testing the load-carrying capacity or "film strength" of lubricants is obvious.

Full details are obtainable from British Timken, Ltd., Cheston Road, Aston, Birmingham, 7.

AERONAUTICAL PATENT SPECIFICATIONS

The numbers in brackets are those under which the Specifications will be printed and abridged, etc.)

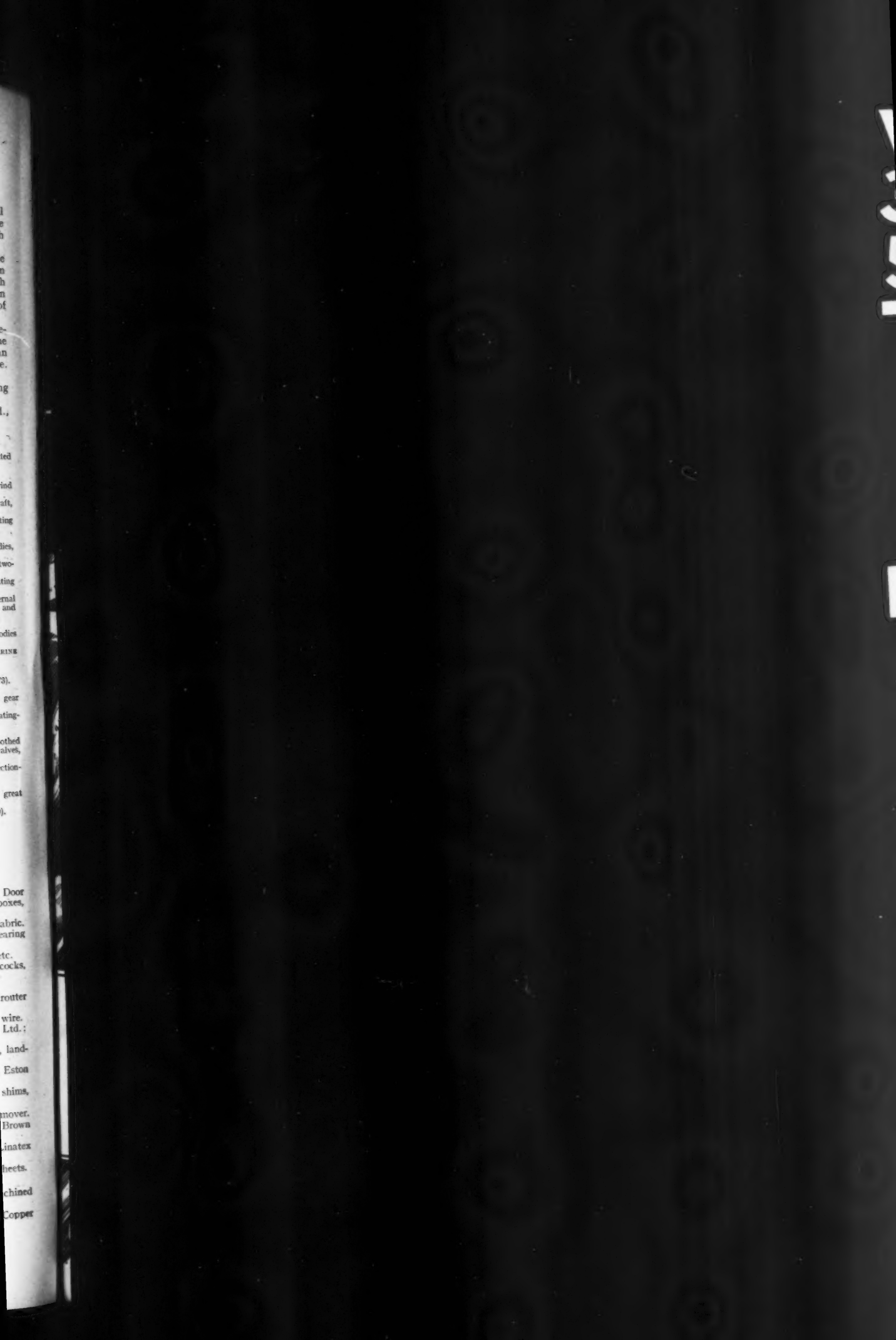
(*Published April* 6, 1939.)

24332. GENERAL AIRCRAFT, LTD., and HARVEY, W. W.: Direction-of-wind indicating apparatus (502,022).
24591. SAUNDERS, R.: Means for operating flying or other controls of aircraft, airships, and other ships and vehicles (502,093).
25101. AUTOMOTIVE PRODUCTS CO., LTD., and CLENCH, E. C. S.: Double acting liquid-pressure remote-control systems (502,114).
32349. SPERRY GYROSCOPE CO., INC.: Gyroscope apparatus (501,856).
4862. A.T.S. CO., LTD., and NORTH, J. D.: Thin sheet covered aircraft bodies, wings and the like (501,947).
12508. AEROPLANI CAPRONI SOC. ANON., and FUSCALDO, O.: Supercharged two-stroke internal combustion engines (501,995).
12679. SPERRY GYROSCOPE CO., INC.: Method of and apparatus for locating distant objects such as aircraft (501,996).
13949. DAIMLER-BENZ AKT.-GES.: Cooling liquid circulation systems for internal combustion engines and other apparatus, e.g., liquid clutches and particularly the lubrication systems of aircraft engines (501,998).
15337. ROUANET, R. L. M. F., and REY, F. V. A. J.: Aircraft (501,879).
21423. LAMMERMANN, H.: Manufacture of aeroplane stays or like hollow bodies (502,067).
31470. GRANAT, E., and COMPAGNIE DES FORGES ET ACIERIES DE LA MARINE ET D'HOMECOURT: Air logs (502,011).

(*Published April* 13, 1939.)

16615. SPERRY GYROSCOPE CO., INC.: Automatic pilots for aircraft (502,473).
24898. JABLONSKY, B.: Plywood (502,413).
27244. FAIREY AVIATION CO., LTD., and FORSYTH, A. G.: Variable-speed gear (502,371).
31290. SHORT BROS. (ROCHESTER AND BEDFORD), LTD., and PETERS, R.: Locating-pins for use in holding together work to be riveted (502,374).
525. BENDIX AVIATION CORPORATION: Brakes (502,277).
4174. TRIGGS, W. W. (legal representative of STRUBE, C. (deceased)): Toothed gearing and stress-limiting devices for actuating winches, sluice valves, aircraft landing-appliances, and the like (502,382).
15476. LORENZ AKT.-GES., C.: Transmitting arrangements for radio-direction-finding systems (502,302).
20957. KAMMER, G. S.: Aircraft construction (502,322).
26086. JAEGER-AVIATION: Gyroscopic horizons allowing the reading of great longitudinal inclinations (502,462).
27227. ARADO FLUGZEUGWERKE GES.: Landing-hook for aircraft (502,240).
30582. ARADO FLUGZEUGWERKE GES.: Controls of aircraft (502,336).

CONTRIBUTORS to the HAMPDEN'S CONSTRUCTION

(*Continued from p.* 454.)

Rawlplugs, Ltd.: Screws, Rawlplugs, etc.
Raymond and Stoke, Ltd.: Pattern castings.
Reliance Name Plate Mnfg. Co.: Ivorine discs.
Reynolds Tube Co., Ltd.: Steel, alloy tubing.
R.F.D. Co., Ltd.: Wind indicators.
A. Richards and Co., Ltd.: Washers, packing rings.
J. Rigby and Son, Ltd.: Welding and locking wire.
Rolls Razor, Ltd.: Tubular rivets to drawings, distance tubes, etc.
Ross, Courtney, Ltd.: Terminals.
Rotherham and Sons: Nipples, collars, sleeves, unions, etc.
Rubery, Owen and Co., Ltd.: Bolts to drawing, special pins, screws, etc.
L. A. Rumbold and Co., Ltd.: Pilots' seats.
Geo. Salter and Co., Ltd.: Springs, etc.
Schofield and Samson, Ltd.: Hand bending machines.
Sedgewicks, Ltd.: Bending machines, blades, key bearings, etc.
Selson Machine Tool Co., Ltd.: Tools.
Serck Radiators: Oil coolers, radiators.
Sheffield Twist Drill and Steel Co., Ltd.: Twist drills, Morse taper shanks, etc.
H. C. Shepherd and Co.: Tools and parts.
Simmonds Aerocessories, Ltd.: Aircraft wing treads, Wondergrip rubber, screws, bolts, nuts, etc.
Skefko Ball Bearing Co., Ltd.: Ball bearings.
Small Electric Motors, Ltd.: Machined parts.
Smiths Aircraft Instruments: Instruments.
Smith-Clayton Forge, Ltd.: Stampings, engine rings, forgings, etc.
S. B. Smith and Co., Ltd.: Jubilee clips, screws, gauges, etc.
Smith's Stamping Works: Aluminium forgings, stampings.
Soag Machine Tools, Ltd.: Milling machine.
Spauldings, Ltd.: Ebonite details, red-fibre washers, fibre fairleads.
Geo. Spencer, Moulton, Ltd.: Rubber washers, hose, rubber rings, etc.
Sperry Gyroscope Co., Ltd.: Artificial horizons and directional gyros.
Spicers, Ltd.: Systoflex tubing, etc.
The Standard Insulating Co., Ltd.: Rubber bushes.
Stedall and Co., Ltd.: Hinges, turnbuttons, ring catches, etc.
Leo. C. Steinle, Ltd.: Tools and tool holders.
J. Stone and Co., Ltd.: Castings, rivets, etc.
S. M. Stuart-Turner and Co., Ltd.: Machined parts.
Superflexit Co., Ltd.: Pipes.
H. D. Symons and Co., Ltd.: Insulating sleeving.
Tecalemit, Ltd.: Grease nipple units, Tecalemit greasers, adaptor.
Herbert Terry and Sons, Ltd.: Clips.
Thermotank, Ltd.: Louvres.
Titanine, Ltd.: Dope and varnish.
Triplex Safety Glass Co., Ltd.: Glass windows, Perspex panels.
Ernest Turner Elec. Instruments, Ltd.: Door handles, jettison switches, switch boxes, plugs.
Ulster Weaving Co., Ltd.: Aero linen fabric.
Wm. Urquhart, Ltd.: Levere shearing machine.
Venesta, Ltd.: Metal-faced plywood, etc.
Vickers Armstrong, Ltd.: Air drills, cocks, etc.
Vokes, Ltd.: Oil cleaners.
Wadkin and Co., Ltd.: Cutters for router machine.
G. P. Wall, Ltd.: Spring steel, piano wire.
The Watford Engineering Works, Ltd.: Machined parts.
Websters Metal Works: Plate fittings, landing flare chutes.
Weston Elec. Instruments Co.: Eston pyrometers, etc.
B. Whittaker, Ltd.: Laminum shims, washers, packing plates, etc.
Wilcot (Parent) Co., Ltd.: Paint remover.
Wilkins, Cambell and Co., Ltd.: Brown beeswax, sealing strips.
Wilkinson Rubber Linatex, Ltd.: Linatex sections, strip details, etc.
Wood Sons (Wisewood), Ltd.: Steel sheets.
Chas. Wright, Ltd.: Pressings.
Wyndham, Hewitt and Co., Ltd.: Machined parts.
Yorkshire Copper Works, Ltd.: Copper tubing.